FINANCIAL ASSISTANCE
ANNOUNCEMENT OF
FUNDING OPPORTUNITY

Solid State Lighting Product Development

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SECTION I - FUNDING OPPORTUNITY DESCRIPTION

1.1 SUMMARY

Solid State Lighting

Goal:
By 2015, develop advanced solid state lighting technologies that compared to conventional lighting technologies, are much more energy efficient, longer lasting, and cost competitive by targeting a product system efficiency of 50 percent with lighting that accurately reproduces sunlight spectrum.

The Department of Energy (DOE), National Energy Technology Laboratory (NETL), on behalf of the Office of Energy Efficiency and Renewable Energy's (EERE) Building Technologies Program (BT), is seeking applications for product development of Solid State Lighting (SSL) Technologies. DOE has set aggressive and ambitious goals for SSL Research and Development: By 2015, to develop advanced solid state lighting technologies that, compared to conventional lighting technologies, are much more energy efficient, longer lasting, and cost-competitive. The objective of this Funding Opportunity Announcement is to solicit applications from industrial partners that begin to examine certain high priority product development activities that will advance the lighting research and development (LR&D) portfolio of SSL beyond its present embryonic state. Like previous funding opportunity announcements in the SSL Program, this one also seeks to advance the collaborative atmosphere of the LR&D SSL program to identify potential product concepts; and incorporate into products supportive technologies that are novel, innovative and groundbreaking, that fill technology voids or that otherwise represent a technological advancement of SSL products.

While the current generation of SSL products are commercially viable and in some instances, may serve the energy conservation goals of the DOE, they are most often used in markets that do not produce the large energy conservation objectives sought by DOE.

1.2 BACKGROUND INFORMATION

The lighting industry is nearly 100 years old and is often characterized as a mature industry. As with any mature commodity-based business, little innovation or research is expended towards product evolution or innovation beyond what is needed to maintain manufacturing, marketing and distribution costs within acceptable parameters. Thus, little industrial funding is available to support a concentrated research effort aimed at exploiting the promise of a revolutionary technology like SSL. Throughout the past four years, with well over 10,000 person hours invested by industry, academia and Government, the prevailing theme that has surfaced repeatedly is that the promise of solid state lighting will only be produced through a focused and concentrated effort between the stake holders.

Electricity consumed for lighting represents about 8.2 Quads or nearly 8.5 % of all the primary energy consumed annually by the Nation. Lighting also consumes 22% of all electricity in buildings.

Today, the lighting industry in North America is worth approximately $45 Billion in sales annually. Of this, approximately $12 Billion is associated with lamps while the remaining sales are divided between fixtures, components (including ballasts and controls) and services such as design and maintenance. High brightness LED sales, a popular product thought by many to be the nearest term solution to SSL, is a $1 to $2 Billion business with exponential growth prospects. Still, even though each of the major lamp manufacturers is involved in some sort of an SSL venture, most of the technology development is being advanced by companies unfamiliar with the century-old experiences in the fiercely competitive environment associated with lighting. For these reasons, it is difficult to imagine that the lighting industry would undertake the development of energy efficient and cost competitive SSL products alone.

To address these issues and to advance energy conservation in lighting in US Buildings, the DOE's Building Technologies Program maintains a Lighting Research and Development (LR&D) activity. Key to the objectives of this activity is its mission statement.

Lighting Research and Development Program

Mission:
To increase end-use efficiency in buildings by aggressively researching new and evolving lighting technologies, in close collaboration with partners, to develop viable methodologies that have the technical potential to conserve 50% of electric lighting consumption by 2010.

To insure that its research portfolio meets critical and evolving needs in a timely fashion, the LR&D activity has and continues to host industry-led efforts to develop and maintain a series of technology road maps for the various technologies that comprise the lighting business. While not the only lighting technology of interest within the Building Technologies Program portfolio, SSL is the ***singular*** focus of the present Funding Opportunity Announcement. SSL has been the focus of five discrete road-mapping exercises during the past three years. The most recent event was held in November, 2003. It was successful in prioritizing the product development research areas described in this Funding Opportunity Announcement. These technical priorities and need areas are outlined in Article 1.6, "Program Areas of Interest." Information developed for and by this workshop may be viewed and downloaded at http://www.netl.doe.gov/ssl/. Workshops like this one are planned in the future and will help to align Government SSL R&D directions with the high-priority needs identified by industry.

The SSL portfolio has developed a specific statement of objectives tailored to the aggressive needs suitable for general illumination applications. It targets aggressive performance goals that, if met and successfully deployed into the marketplace, will achieve the energy conservation goals of the LR&D program while meeting or exceeding the performance attributes of electric light that allows for direct comparison to natural sunlight spectra.

As the relevant SSL technology base matures, it is anticipated that the level of technology maturation will advance from the present level, applied research, eventually to market conditioning once the targets for efficiency, cost, longevity, stability and control are demonstrated in a product environment. This sequence of technology maturation is illustrated graphically in the figure below.

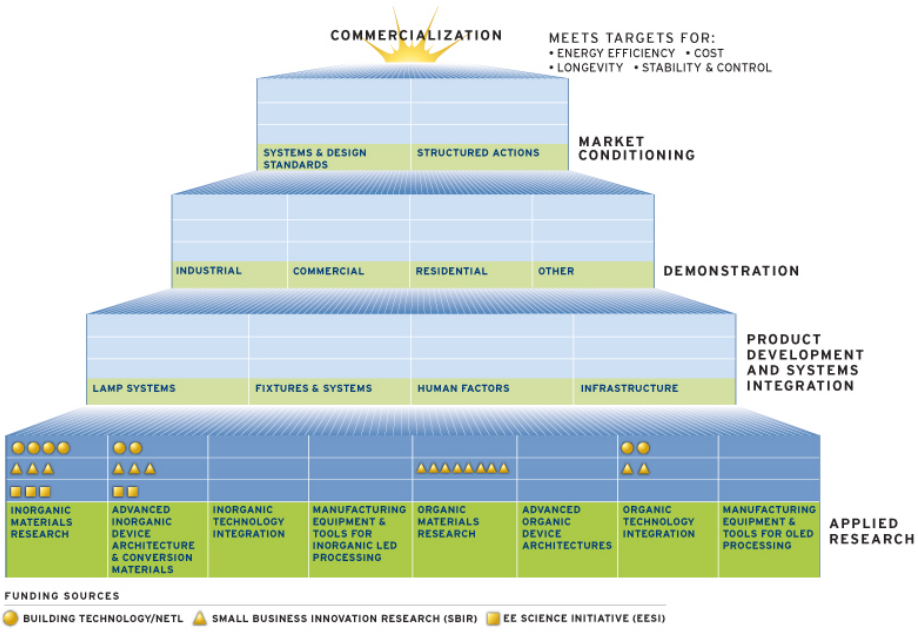


Figure 1 – Pyramid Schematic Representation of the DOE's Solid State Lighting Portfolio.

Resulting in part from the November, 2003 meeting, EERE will conduct a series of actions to complete the levels of the pyramid. One action, running concurrently to this Funding Opportunity Announcement, will be to competitively select an organization or association (referred to as the SSL Partnership) that broadly represents the SSL manufacturing industry. It is envisioned that, among other things, the Partnership members will provide input and prioritization of future Core Technology needs. The Government expects to enter into a Memorandum of

Agreement (MOA) with the selected Partner since no Federal funding will be provided to the MOA Partner. Another set of actions, i.e. related to core technologies, seeks to identify the Core Technology needs in an attempt to address the crosscutting or technology gap needs, benefiting multiple technology platforms and manufacturers.

Current information about the DOE's SSL portfolio can be found at: **http://www.netl.doe.gov/ssl/**

Information about advanced building technologies, systems and partnership opportunities that promote energy efficiency, renewable energy and pollution prevention is at: **http://www.eren.doe.gov/buildings/**

A summary report, titled "Illuminating the Challenges: Solid State Lighting Portfolio Planning Workshop Report", detailing the SSL workshop can be found at: **http://www.netl.doe.gov/ssl/**

1.3 OBJECTIVES

The focus of this Funding Opportunity Announcement is to solicit applications from industrial organizations that begin to examine certain high priority product development activities that will advance the LR&D portfolio of SSL beyond its present embryonic state. Like previous funding opportunity announcements in the SSL series, this one also seeks to advance and promote the collaborative atmosphere of the LR&D SSL program to identify potential product concepts; and incorporate into products supportive technologies that are novel, innovative and groundbreaking or that fill technology voids or that otherwise represent a technological advancement of SSL products.

The overall objectives of the SSL portfolio span four broad categories as are illustrated in the Pyramid Schematic in Figure 1. The present Funding Opportunity Announcement (FOA) is focused on solid state lighting product development but includes application and, in some cases, a product-focused application of applied research supported by academia, national laboratories or the private sector under other announcement(s) or development programs.

The Program Areas of Interest described in Article 1.6 are generally representative of the priority R&D topics that were recommended by the SSL community at the SSL Workshop in November 2003. Quality applications should target a specific SSL product and make notable progress toward achieving performance and price goals, as noted in Table 1 (below) for commercially available products or for lab devices in Table 2. Given the maturity of OLED technology relative to white light products, similar detailed forecast data is not available. These goals for the proposed product (especially the efficacy) will be used in the estimation of energy savings, as noted in Article 5.2, Criterion #2. The capability of the applicant's product to save energy in the near-term is required, not the potential of SSL in 20 years (or other broader, more future performance).

1.4 PROJECTED PERFORMANCE OF WHITE-LIGHT LED DEVICES

In an effort to provide a better basis for assessing the energy savings potential of Solid State Lighting (SSL), the Department of Energy (DOE) studied the price and performance of white light emitting diode (LED) devices operating at a correlated color temperature (CCT) of approximately 3000K and a color rendering index (CRI) of 80 or higher. Two projection estimates were prepared, one for commercially available LEDs, and one for certain future laboratory prototype LEDs. Exhibit B provides some of the background and rationale behind these projections.

Table 1 presents the projected performance of commercially available white-light LEDs. These data represent the "high CRI" SSL sources projected under the accelerated investment scenario of a recent DOE study.[1] The cost and performance estimates were developed in consultation with industry, and represent the average performance of white-light LED systems sold to consumers.

[1] *Energy Savings Potential of Solid State Lighting in General Illumination Applications,* Building Technologies Program, Office of Energy Efficiency and Renewable Energy, US DOE, prepared by Navigant Consulting, Washington DC, November 2003. Available on-line at: www.netl.doe.gov/ssl

Table 1. Commercially Available White-Light LED System Efficacy Estimates*

	2005	2006	2007	2008	2009	2010	2015	2020	2025
Efficacy (lumens/watt)	47	56	66	76	88	99	142	158	162
Lamp Life (1000 hours)	16	19	23	28	36	45	87	98	100
Lamp Cost ($/klm)	146	127	107	86	67	51	11	4.3	3.3

* Note: This projection is for white-light LEDs operating at a CCT of 3000K and a CRI of 80 or higher, and includes system losses. This projection is based on the accelerated investment scenario for High CRI SSL sources.

Table 2 provides a projection of the performance levels the Department anticipates for laboratory LEDs. These data represent the anticipated performance estimates of future prototype LEDs to be developed in leading research laboratories in the United States.

Table 2. Laboratory Efficacy Estimates for White-Light LED Technology*

	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Efficacy (lumens/watt)	90	103	115	125	132	154	183	196	199	200
Life (1000 hours)	28	36	45	55	65	74	96	100	100+	100+

* Note: This projection is for white-light LED chips operating at a CCT of 3000K and a CRI of 80 or higher. These performance characteristics have not been demonstrated yet.

Over the next five years, commercialized white-light LEDs will be driven primarily by phosphor-converting LED (pcLED) devices. In this time frame, it is expected that research laboratories will focus on both improving white-light production techniques for pcLEDs while expanding their research into color-mixing approaches to white-light production that incorporate three or more discrete LED elements [or die]. Breakthroughs in phosphor technology aside, color-mixing is thought by many to represent the most promising approach for developing high-efficacy, white-light LEDs in the long-term. For example, a three color element device that operates at a CCT of 3000K and 80 CRI, has a theoretical maximum efficacy of more than 400 lumens per watt. For this system, assuming a 50% device efficiency, overall device efficiency could exceed 200 LPW. The principal advantage of the color-mixing method is that it does not involve phosphors, thereby minimizing losses in the white-light production mechanism. However, discrete color-mixing incorporates challenges such as multi-chip mounting, sophisticated optics for blending discrete colors, and color control feedback circuitry that may impact its value proposition.

1.5 TECHNOLOGY MATURATION STAGES

Successful applications submitted to this FOA shall address specific products either by providing certain enabling applied research specific to a product design and/or by producing engineering development leading to a specific product design. Thus, applications may include applied research, but its relevance to a specific product must be clearly identified. The ultimate product must be fully described and its anticipated price and performance should be clearly elucidated. The contribution that the proposed project will make towards the realization of the product must also be clearly described. Any variation from the price and performance projections of Table 1 must be clearly identified and explained.

The technology maturation stages eligible for this Funding Opportunity Announcement are limited to Stage 2 through and including Stage 5. Each stage is defined below in order to provide the overall picture of which stage a particular R&D activity on a technology may fit. Applicants must identify the stage(s) in which their effort will reside.

Technology Maturation Stage 1 – Basic Science Research (excluded from this FOA)

Fundamental science exploration is performed to expand the knowledge-base in a given field. Scientific principles (with data-empirical and/or theoretical derivation) are formulated and proven. The output from these projects would generally be peer-reviewed papers published in recognized scientific journals. Specific applications are not necessarily identified in Stage 1.

Technology Maturation Stage 2 - Applied Research

Scientific principles are demonstrated, an application is identified, and the technology shows potential advantages in performance over commercially available technologies. Lab testing and/or math modeling is performed to identify the application(s), or provide the options (technical pathways) to an application. Testing and modeling add to the knowledge base that supports an application and point to performance improvements.

Technology Maturation Stage 3 – Exploratory Development

A product concept addresses an energy efficiency priority. From lab performance testing, down select from alternative technology approaches for best potential performance, via selection of materials, components, processes, cycles, and so on. With lab performance testing data, down select from a number of market applications to the initial market entry ideas. This product concept must exhibit cost and/or performance advantages over commercially available technologies. Technical feasibility should be demonstrated through component bench-scale testing with at least a laboratory breadboard of the concept.

Technology Maturation Stage 4 – Advanced Development

Product concept testing is performed on a fully functional lab prototype – "proof of design concept" testing. Testing is performed on prototypes for a number of performance parameters to address issues of market, legal, health, safety, etc. Through iterative improvements of concept, specific applications and technology approaches are refocused and "down selected." Product specification (for manufacturing or marketing) is defined. Technology should identify clear advantages over commercially available technologies, and alternative technologies, from detailed assessment.

Technology Maturation Stage 5 – Engineering Development

"Field ready prototype" system is developed to refine product design features and performance limits. Performance mapping is evaluated. Performer conducts testing of a field-ready prototype/system in a representative or actual application with a small number of units in the field. The number of units is a function of unit cost, market influences (such as climate), monitoring costs, owner/operator criteria, etc. Feedback from the owner/operator and technical data gathered from field trials are used to improve prototype design. Further design modifications and re-testing are performed as needed.

Technology Maturation Stage 6 – Product Demonstration (excluded from this FOA)

Operational evaluation of the demonstration units in the field is conducted to validate performance as installed. Third party monitoring of the performance data is required, although less data is recorded relative to the "field ready prototype" test in Stage 5. Pre-production units may be used. Size of demo is a function of unit cost, monitoring cost, etc., and involves relatively more visibility. Energy savings are measured, with careful analysis of economic viability and field durability for specific applications.

1.6 PROGRAM AREAS OF INTEREST

There are four broad Areas of Interest for this Funding Opportunity Announcement and six applied research sub-topics that contribute to the areas. Each represents a high priority applied research or product development area that was identified in the SSL Workshop of November 2003. Applicants must select and target only one (1) Area of

Interest per application. Although there may be some technical overlap, a single application must be submitted for each technology or technical approach that best fits into a single Area of Interest.

For example, a future product concept might involve LEDs used in a luminaire design (Area of Interest 1). One technical approach might be to use pc-LEDs and another might use many different color LEDs combined in a matrix. Each of these would represent a different approach to a single Area of Interest and must be proposed separately. Furthermore, in order to meet the price and performance goals of Table 1, an advanced LED architecture might be required (sub-topic 1.2.1). In this simple example, applied research aimed at developing this new LED architecture might be necessary before devices can be made at the efficacy levels proposed. Thus, an application might include such applied research from subtopic 1.2.1 but would be targeted to a single, specific technical approach ultimately to be embodied in a product as described in Area of Interest 1. More than one sub-topic may be included for each response to one Area of Interest.

The Areas of Interest target product development opportunities in both Light Emitting Diodes (LED) and Organic Light Emitting Diodes (OLED). Applicable to the Areas of Interest, six sub-topics comprised of high priority, applied research are also described. **Applications may or may not include the performance of the described sub-topics but, if included, such performance must be proposed under one of the Areas of Interest.** Descriptive information on the Areas of Interest is provided in the following paragraphs:

Area of Interest 1: LED Luminaire Design and Materials – Area of Interest Number: (DE-PS26-04NT42118-01)

Current SSL devices are limited in optical output and overall efficacy by many factors including out-coupling efficiency sometimes termed external quantum efficiency and thermal management, a product of internal and external quantum efficiency being less than unity. While significant improvements in these areas have been made over the past few years, there must be considerable improvement in price and performance if SSL is to realize the predicted energy conservation promised. Numerous limitations in materials and packaging constrain the products available today to conspicuity applications such as traffic signals, display applications such as cell phones and specialty illumination applications such as flashlights where their performance attributes are extremely well matched to the requirements. While the complete understanding of how today's materials systems limit performance remains largely unknown, this is the subject of a companion announcement (see "Core" research FOA located at www.netl.doe.gov/ssl). Instead, applied research and engineering that incorporates this new found knowledge and applies it to products and packages that exceed present performance limitations of 50 to 80 LPW for LEDs is sought. Applications may be submitted that seek to develop the necessary engineering expertise to use novel materials and systems in practical devices; make practical materials systems using alternative, potentially low cost processes; incorporate novel packaging designs and geometries; explore innovative light extraction mechanisms; or manage heat transfer in novel yet effective ways.

Building upon established and demonstrated scientific principles, successful applications shall clearly illustrate the potential advantage(s) of the proposed innovation of design or materials or both in price and performance over commercially available technologies. This may be demonstrated either by laboratory testing and/or mathematical modeling. In any case, the proposed work must clearly demonstrate the commercial viability and increased value relationship to the DOE in terms of reduced cost, increased optical output and increased efficacy. The target values of these metrics are fully described for LEDs in Article 1.4

Thus, device improvements of several orders of magnitude to the price and performance of these devices are vital to achieve these goals. It is possible that the increases sought by the research and development under this announcement may not achieve these sizable but possible improvements alone. Additional, future core research may be needed or product advancements in areas not identified under this announcement may be necessary. These may be included in future funding opportunity announcements but are specifically excluded from the present one.

[For more information, refer to SSL research topic 2.1.1 of *Illuminating the Challenges: Solid State Lighting Portfolio Planning Workshop Report* at http://www.netl.doe.gov/ssl/]

Area of Interest 2: High Efficiency, Reliable, Intelligent Electronics for LEDs – Area of Interest Number: (DE-PS26-04NT42118-02)

High efficiency, reliable, intelligent power supplies and specialized electronics for LED products are already under development for applications that presently demand them. As a result, products for non-general illumination applications tend to drive the development of these electronics potentially limiting their efficiency and performance for general illumination needs. Moreover, the present day, commercially available power supplies are limited in capability and do not include the flexibility and functionality required to fully satisfy the unique performance requirements anticipated for successful near-term SSL products. While the final, longer-term product vision for SSL remains unknown, it is clear that near-term SSL products, built upon existing technology or research supported under the DOE LR&D program or elsewhere, may become commercial successes by serving the immediate needs of the general illumination industry. Thus, highly efficient, reliable, flexible, intelligent and advanced electronics will be required to power or be a part of these nearer term SSL devices and systems.

Even though the final SSL products may not possess the same power requirements as the near-term products, development of specialized power supplies and intelligent electronics tailored to these near-term products may allow them to be as efficient as possible. Thus, high-reliability, programmable power supplies and drive electronics that are either designed for compatibility with existing products or are flexible or adaptive enough to accommodate future SSL innovations are sought. Applications that include special features such as dimming, networking, controls and maintenance of luminous output over their lifetime will be a special interest. Only applications that specifically address this opportunity will be accepted under this area of interest. Each application shall fully describe the innovation and compare performance of it to existing electronics. Price and performance comparisons between existing electronics and the anticipated innovation must be included in each application.

[For more information, refer to SSL research topic 2.1.4 of *Illuminating the Challenges: Solid State Lighting Portfolio Planning Workshop Report* at http://www.netl.doe.gov/ssl/]

Sub-Topics Descriptions (from the November 2003 SSL Planning Meeting):

The following sub-topics (1.1.2, 1.2.1 and 1.2.2) may be addressed in applications in response to Areas of Interest 1 or 2. The reference numbers provided refer to the *Illuminating the Challenges: Solid State Lighting Portfolio Planning Workshop Report*.

1.1.2 High Efficiency Visible and Near UV (>380 nm) Semiconductor Materials for LED Based General Illumination Technology

Current nitride compound semiconductors are incapable of achieving the price and performance targets described in the SSL program objectives for a variety of reasons. While significant improvements have been made, today's products are not able to meet these requirements primarily due to limitations in materials and packaging. Also, a complete basic understanding of how material quality ultimately effects device performance is still lacking. Significant advancements in the basic materials technology associated with visible and near UV LEDs is required to advance performance characteristic of current devices beyond their present limitations of 50 to 80 LPW. These advancements must not only produce the substantial gains in the light production efficiency required but must also address the significant costs normally associated with the complex and labor intensive epitaxial growth required to produce these devices. Applied research in both conventional nitride systems as well as exploration of novel material systems is necessary to ultimately produce the efficient materials system(s) required to improve the price and performance of these devices the several orders of magnitude required to make them practical solutions to general illumination challenges. Also, advancements in P-doping efficiency and novel charge introduction structures may produce significant fundamental advancements in existing materials systems. Advancements in high purity process materials and growth structures may also significantly improve device performance by limiting photon inhibiting processes thought to be associated with defects, dislocations, and other crystalline artifacts.

1.2.1 Advanced Architectures and High Power Conversion Efficiency Emitters

Advanced device architectures that optimize both electrical transport and optical properties will be needed to achieve longer-term efficiency goals in excess of 160 lumens/Watt and consequently, meaningful energy savings. Traditional LED designs will rely on novel fabrication methods, including chip-shaping, texturing, laser liftoff, etching, and novel metallization for improved efficiency. More advanced light emitting designs that might include micro cavities, photonic lattices, quantum dots, edge-emitting and vertical-cavity laser structures are sought under this sub-topic. Fundamental advancements and novel innovations associated with chip-level architectures and high power conversion efficiency are believed by many to be the key to production of significant increases in power handling capability. Applied research directed at novel chip scaling, producing practical and cost efficient multi-color chips, or resonant cavity devices such as lasers or directional emitters may each produce the desired increases in power capability. Also, for conventional chip designs, the dimensions and locations of contacts are limiting and as chips become larger and of greater power handling capacity, development of novel contact materials and geometries will become increasingly important.

1.2.2 High Temperature, Efficient, Long-life Phosphors, Luminescent Materials for Wavelength Conversion and Encapsulants

Near term SSL general illumination products are expected to be designed around near UV or blue emitting LEDs that capture a portion of their monochromatic emissions with a yellow phosphor that in turn converts some of the pump light into a broader spectrum whose combined emissivity approximates white light of good color and spectral power. Although many materials that are currently used for these purposes are reasonably efficient, even more efficient phosphors and/or luminescent materials may bring an immediate increase in device efficiency. For example, multi-photon processes can produce quantum yields in excess of unity even for relatively low energy excitations such as 380 nm. Suitable hosts and materials systems need to be developed to advance these to practical, energy efficient devices for general illumination products. Applied research is sought in this area that investigates novel phosphors and/or luminescent material synthesis and blends. Also included in this sub-topic are advancements in epoxy or other encapsulants and die mounting materials.

Within down-conversion approaches to white light generation, more efficient (>95%), stable (100,000 hrs), high-temperature (>150 degrees C), environmentally friendly phosphors with no dissipative optical absorption or scattering will need to be developed. Novel approaches are also needed and sought for the synthesis and processing of novel conversion materials, including, but not limited to nanocrystalline semiconductors, photonic lattices, quantum dots, organic coordination-compound phosphors, phosphor blends or slurries, and coated phosphors.

High-drive, high-lumen output LED devices place demanding performance requirements on encapsulation materials. Future encapsulation materials for high-power general illumination products will need to have an index > 1.6, high transmission (>80%) through thick layers throughout the visible spectrum (440-650 nm), UV filtering and resistance, low H_2O permeability for up to 100,000 hours, and withstand high processing and operation temperatures (100-150 C).

Area of Interest 3: OLED Luminaire Design and Materials – Area of Interest Number: (DE-PS26-04NT42118-03)

Current SSL devices are limited in optical output and overall efficacy by many factors including out-coupling efficiency sometimes termed external quantum efficiency and thermal management, a product of internal and external quantum efficiency being less than unity. While significant improvements in these areas have been made over the past few years, there must be considerable improvement in price and performance if SSL is to realize the predicted energy conservation promised. Numerous limitations in materials and packaging constrain the products available today to conspicuity applications such as traffic signals, display applications such as cell phones and specialty illumination applications such as flashlights where their performance attributes are

extremely well matched to the requirements. While the complete understanding of how today's materials systems limit performance remains largely unknown, this is the subject of a companion announcement (see "Core" research FOA). Instead, applied research and engineering that incorporates this new found knowledge and applies it to products and packages that exceed present performance limitations of approximately 15 LPW for OLEDs is sought. Applications may be submitted that seek to develop the necessary engineering expertise to use novel materials and systems in practical devices; make practical materials systems using alternative, potentially low cost processes; incorporate novel packaging designs and geometries; explore innovative light extraction mechanisms; or manage heat transfer in novel yet effective ways.

Building upon established and demonstrated scientific principles, successful applications shall clearly illustrate the potential advantage(s) of the proposed innovation of design or materials or both in price and performance over commercially available technologies. This may be demonstrated either by laboratory testing and/or mathematical modeling. In any case, the proposed work must clearly demonstrate the commercial viability and increased value relationship to the DOE in terms of reduced cost, increased optical output and increased efficacy. The target values of these metrics for OLEDs are not as defined as for LEDs. However the limited work done by the DOE in this area projects that the information in Table 3 are, for laboratory devices, reasonable performance estimates for today and targets for 2008.

Table 3. Laboratory Device Performance for OLEDs

	Today	**2008**
Efficacy	15 lpw	100 lpw
Brightness	850 cd/m^2	850 cd/m^2
Lifetime	> 400 hrs	> 10,000 hrs
CRI	88	> 90

Thus, device improvements of several orders of magnitude to the price and performance of these devices are vital to achieve these goals. It is possible that the increases sought by the research and development under this announcement may not achieve these sizable but possible improvements alone. Additional, future core research may be needed or product advancements in areas not identified under this announcement may be necessary. These may be included in future funding opportunity announcements but are specifically excluded from the present one.

Area of Interest 4: High Efficiency, Reliable, Intelligent Electronics for OLEDs – Area of Interest Number: (DE-PS26-04NT42118-04)

High efficiency, reliable, intelligent power supplies and specialized electronics for OLED products are already under development for applications that presently demand them. As a result, products for non-general illumination applications tend to drive the development of these electronics potentially limiting their efficiency and performance for general illumination needs. Moreover, the present day, commercially available power supplies are limited in capability and do not include the flexibility and functionality required to fully satisfy the unique performance requirements anticipated for successful near term SSL products. While the final, longer term product vision for SSL remains unknown, it is clear that near term SSL products, built upon existing technology or research supported under the DOE LR&D program or elsewhere, may become commercial successes by serving the immediate needs of the general illumination industry. Thus, highly efficient, reliable, flexible, intelligent and advanced electronics will be required to power or be a part of these nearer term SSL devices and systems.

Even though the final SSL products may not possess the same power requirements as the near term products, development of specialized power supplies and intelligent electronics tailored to these near term products may allow them to be as efficient as possible. Thus, high-reliability, programmable power supplies and drive electronics that are either designed for compatibility with existing products or are flexible or adaptive enough to accommodate future SSL innovations are sought. Applications that include special features such as dimming, networking, controls and maintenance of luminous output over their lifetime will be a special interest. Only applications that specifically address this opportunity will be accepted under this area of interest. Each

application shall fully describe the innovation and compare performance of it to existing electronics. Price and performance comparisons between existing electronics and the anticipated innovation must be included in each application.

Sub-Topics Descriptions (from the November 2003 SSL Planning Meeting):

The following sub-topics (1.5.1, 1.6.1 and 1.6.2) may be included in applications in response to Areas of Interest 3 or 4. The reference numbers provided refer to the *Illuminating the Challenges: Solid State Lighting Portfolio Planning Workshop Report*.

1.5.1 High Efficiency, Low-Voltage, Stable Materials for OLED-Based General Illumination Technology (hosts, dopants, and transport layers)

Today, OLEDs designed for general illumination purposes may be derived from those normally associated with display applications. This is not ideal as general illumination OLEDs have unique price and performance requirements that will allow them to perform as viable alternatives to conventional luminous sources. To evolve into this new performance domain, applied research in novel materials hosts, alternative dopants and advancing a more comprehensive understanding of the role and design rules for charge transport in layers is sought.

Current OLED materials simply do not have the efficiency or lifetime performance necessary to qualify them as viable candidates for the demanding general illumination market. Estimates of lifetime and efficiencies necessary for OLED based general illumination are roughly 50,000 hours and 100 lumens/Watt, respectively. Lifetimes and efficiency of state-of-the-art white OLEDs (at 850 cd/m^2) are about 400 hours and 15 LPW respectively. To realize the full potential of OLED technology, new materials and systems are needed that offer the promise of vastly improved efficiency and stability in the active regions of the OLED device- cathode and anode layers, electron and hole transport and injection layers, emission layers, and carrier blocking layers. New phosphorescent OLED systems with nearly 100% internal quantum efficiency at high current densities are required in the red, green, and blue spectral regions. Single molecules that produce a broadband emission and that harvest triplet energies otherwise lost as heat are also needed. Innovative device structures and materials are needed to reduce high-luminance (~1000 cd/m^2) drive voltages from 10-20V to 4-5V. Compatibility with practical methods of current distribution and controls must be assured.

1.6.1 Strategies for Improved Light Extraction and Manipulation

Significant advancements in OLED device performance will require applied research leading to alternative strategies for light extraction and optical management. Conventional limits on OLED out-coupling efficiency are exceptionally low, producing damaging heat instead of useful photonic emissions. Research in this area could include advanced modeling or exploration of novel geometries that promise to achieve 50% or more light extraction efficiency.

Current light out-coupling efficiencies are on the order of 20%. Innovative approaches utilizing surface texturing, gratings, periodic nanostructures, integrated lens or device shaping are necessary to increase the out-coupling efficiency to the desired level of >50%. Even the basic configurations and accepted practice of layering OLED structures may need to be reexamined to ascertain if the ideal geometry is possible. Other novel methods to increase device extraction efficiency, like designing for some level of cavity resonance or mode structure, may hold promise. With the internal quantum efficiency of basic OLED materials systems already approaching 90%, significant advancements in light extraction efficiency or external quantum efficiency (EQE) holds considerable promise. Applications to this sub-topic may be theoretical, modeling oriented or experimental but all should represent novel approaches that offer the potential for large increases in performance, not just incremental increases in EQE, and be directly related to the proposed product.

1.6.2 Novel Device Structures for Improved Performance and Low Cost

Practical OLED devices for general illumination applications must perform in extreme environments very different than those normally associated with today's OLEDs such as display applications like cell phones and PDAs. For the realization of the SSL market penetration sought, OLEDs must be developed that will perform at remarkable brightness levels for periods measured in tens of thousands of hours at extreme temperatures, with no degradation in luminous performance. Thus, applied research directed at meeting these challenges is sought, with the goal that they will ultimately give rise to OLED packages that are as reliable and long lived as required for general illumination applications. Applied research in this area may include novel materials and hosts that help to achieve these goals but may also include innovations associated with existing materials systems and structures.

As the internal efficiency and stability of new OLED materials improves, OLED researchers will need to focus their attention on novel device architectures. This is especially important for maximizing light extraction (as above) but may be just as important for manufacturing cost reductions or for adding additional functionality such as pixilation or variable light attenuation. Equally important and perhaps nearer term are new ideas in the area of white OLEDs to improve the color stability over time and operating conditions. Concepts including RGB blends, monomer-excimer complexes, separate RGB emissive layers, and pixilation need to be explored to determine the optimal approach to OLED-based white light generation.

SECTION II - AWARD INFORMATION

2.1 TYPE OF AWARD INSTRUMENT - COOPERATIVE AGREEMENTS (OCT 2003)

DOE anticipates awarding cooperative agreements under this Program Announcement. DOE will negotiate a Statement of Substantial Involvement prior to the award of any cooperative agreement. This statement will describe the Government's substantial involvement in the project. Examples of possible activities to be performed by DOE which would constitute substantial involvement are:

Reviewing in a timely manner project plans, including technology transfer plans, and redirecting the work effort if the plans do not address critical programmatic issues;

Conducting annual program review meetings to ensure adequate progress and that the work accomplishes the program and project objectives. Redirecting work or shifting work emphasis, if needed;

Promoting and facilitating technology transfer activities, including disseminating program results through presentations and publications;

Serving as scientific/technical liaison between awardees and other program or industry staff; and

Additional monitoring to permit specified kinds of direction or redirection of the work because of interrelationships with other projects.

2.2 ESTIMATED FUNDING (OCT 2003)

Approximately $8 million is expected to be available for new awards under this announcement.

2.3 MAXIMUM AND MINIMUM AWARD SIZE (OCT 2003)

Ceiling (i.e., the maximum amount for an individual award made under this announcement): None

Floor (i.e., the minimum amount for an individual award made under this announcement): None

2.4 EXPECTED NUMBER OF AWARDS (OCT 2003)

DOE anticipates making approximately 2-4 awards under this announcement. However, the Government reserves the right to fund, in whole or in part, any, all, or none of the applications submitted in response to this announcement and will award that number of financial assistance instruments which serves the public purpose and is in the best interest of the Government.

2.5 ANTICIPATED AWARD SIZE (OCT 2003)

DOE anticipates that awards will be in the $1 million to $3 million range for the total project period.

2.6 PERIOD OF PERFORMANCE (OCT 2003)

DOE anticipates making awards that will range from twelve (12) months to thirty-six (36) months in duration. Awards will have project and budget periods that are specific to the project and funding.

SECTION III - ELIGIBILITY INFORMATION

3.1 ELIGIBLE APPLICANTS (OCT 2003)

All types of applicants are eligible to apply, except other Federal agencies, Federally Funded Research and Development Centers (FFRDCs), and nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engage in lobbying activities.

3.2 NOTICE REGARDING ELIGIBILITY OF ORGANIZATIONS DESCRIBED IN SECTION 501(C)(4) OF THE INTERNAL REVENUE CODE (OCT 2003)

Applicant organizations that are described in section 501(c)(4) of the Internal Revenue Code of 1986 and that have engaged in any lobbying activities after December 31, 1995 are not eligible for an award. As set forth in section 3 of the Lobbying Disclosure Act of 1995, as amended, (2 U.S.C. 1602), lobbying activities are defined broadly to include, among other things, contacts on behalf of an organization with specified employees of the Executive Branch and Congress with regard to Federal legislative, regulatory, and program administrative matters.

3.3 COST SHARING OR MATCHING - EPACT (OCT 2003)

The cost share must be at least 20% of the total allowable costs for research and development projects (i.e., the sum of the recipient's allowable costs and the Federal share equals the total allowable cost of the project) and must come from non-Federal sources. (See 10 CFR Part 600 for the applicable cost sharing requirements.) The Department follows cost share goals, as part of the President's Management Agenda. Exceeding the minimum required cost share and/or providing in-kind contributions to enhance commercialization potential are part of the evaluation criteria for proposals. (See Article 5.2, Merit Review Criteria, criterion #4)

3.4 ENERGY POLICY ACT ELIGIBILITY REQUIREMENTS (OCT 2003)

Section 2306 of the Energy Policy Act of 1992 (EPACT) [42 U.S.C. 13525] imposes certain eligibility requirements on awards made under this program. In order to make an award to an applicant that is a business entity, other than a non-profit organization of the type described in section 501(c)(3) of the Internal Revenue Code of 1954, DOE must determine that the applicant's participation will be in the economic interest of the United States and that the applicant is either a U.S. owned company or is incorporated or organized under the laws of any State and that its parent company is incorporated or organized under the laws of a country that affords: (1) to U.S. owned companies opportunities comparable to those afforded to any other company to participate in government-supported joint ventures in energy research and development and in local investment opportunities; and (2) adequate and effective protection for intellectual property rights of the U. S. owned companies. Eligible applicants must be able to meet these two tests.

3.5 FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDC) (JAN 2004)

FFRDC applicants are not eligible for an award. A list of the FFRDC's is available at http://www.nsf.gov/sbe/srs/ffrdc/start.htm. However, an application that includes performance of a portion of the work by a FFRDC will be evaluated and may be considered for award.

3.6 PARTICIPATION BY FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTER CONTRACTORS (OCT 2003)

Federally Funded Research and Development Center (FFRDC) contractors are not eligible for an award under this announcement, but they may be proposed as a team member subject to the following guidelines:

AUTHORIZATION FOR NON-DOE FFRDCS

The Federal agency sponsoring the FFRDC must authorize in writing the use of the FFRDC contractor on the proposed project and this authorization must be submitted with the application. The use of a FFRDC contractor must be consistent with the contractor's authority under its award and must not place the FFRDC in direct competition with the private sector.

AUTHORIZATION FOR DOE FFRDCS

The cognizant contracting officer must authorize in writing the use of a DOE FFRDC contractor on the proposed project and this authorization must be submitted with the application. The following wording is acceptable for this authorization.

> "Authorization is granted for the [ ] Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complimentary to the missions of the laboratory, will not adversely impact execution of the DOE assigned programs at the laboratory, and will not place the laboratory in direct competition with the domestic private sector."

VALUE/FUNDING

The value of and funding for the FFRDC portion of the work will not normally be included in the award to a successful applicant. Usually, DOE will fund a DOE FFRDC contractor through the DOE field work application system and other FFRDC entities through an interagency agreement with the sponsoring agency.

COST SHARE

The applicant's cost share requirement will be based on the total cost of the project, including the applicant's and the FFRDC contractor's portions of the effort.

FFRDC CONTRACTOR EFFORT

The FFRDC effort, in aggregate, shall not exceed 10% of the total estimated cost of the project, including the applicant's and the FFRDC contractor's portions of the effort.

RESPONSIBILITY

The applicant, if successful, will be the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues, including but not limited to disputes and claims, arising out of any agreement between the applicant and the FFRDC contractor.

SECTION IV - APPLICATION AND SUBMISSION INFORMATION

4.1 ADDRESS TO REQUEST APPLICATION PACKAGE (OCT 2003)

This announcement includes all the information needed to complete an application.

4.2 DUNS NUMBER (NOV 2003)

All applicants, except individuals who would personally receive an award under this announcement apart from any business or non-profit organization they may operate, must include a Dun and Bradstreet (D&B) Data Universal Numbering System (DUNS) number in their application. For the purpose of this requirement, the applicant is the entity that meets the eligibility criteria and has the legal authority to apply for an award. For example, a consortium formed to apply for an award must obtain a DUNS number for that consortium. For assistance in obtaining a DUNS number at no cost to you, call the DUNS Number request line at 1 866-705-5711. Be prepared to provide the following information: (1) Organization name; (2) Address; (3) Telephone number; (4) Line of business; (5) Chief executive officer/key manager; (6) Date the organization was started; (7) Number of people employed; (8) Organization affiliation. If you do not already have a DUNS number, you should obtain one as soon as you decide to submit an application.

4.3 PRE-APPLICATION - NOT REQUIRED (OCT 2003)

Pre-applications are not required.

4.4 PROGRAM AREAS OF INTEREST (OCT 2003)

This funding opportunity notice contains multiple program areas of interest identified in the funding opportunity description. Applicants are cautioned that this funding opportunity announcement is a master announcement and that each program area of interest has its own program-specific number for submission of applications. For example, Program Area of Interest 1, "SSL Luminaire Design and Materials," has a funding opportunity number of DE-PS26-04NT42118-01. Applications can not be submitted under the master announcement.

AREA OF INTEREST	APPLY UNDER
LED & OLED	
LED Luminaire Design and Materials	DE-PS26-04NT42118-01
High Efficiency, Reliable Intelligent Electronics for LEDs	DE-PS26-04NT42118-02
OLED Luminaire Design and Materials	DE-PS26-04NT42118-03
High Efficiency, Reliable Intelligent Electronics for OLEDs	DE-PS26-04NT42118-04

Applicants should submit their application under the program area which best fits the majority of the effort to be performed. If an application is submitted under a program area of interest in which the DOE believes fits more appropriately in another program area of interest, the applicant will be directed to resubmit under the appropriate area of interest. Do not submit an identical application under more than one area of interest.

4.5 APPLICATION (MAR 2004)

Applicants must include the following files in their E-Application (See Section IV, Article 4.19, "Other Submission Requirements" for instructions on how to submit your E-Application)

For consistency, the applicant is instructed to use the file names specified below. Filename extensions shall clearly indicate the software application used for preparation of the documents (i.e., "xxx.doc" for Word files or "xxx.pdf" for Adobe Acrobat files).

MANDATORY FILES	FILENAME
Application	APPLICATION.doc

Budget	BUDGET.doc
Budget Justification	BUDGET JUSTIFICATION.doc
Project Summary/Abstract	PROJECT SUMMARY.doc
Project Narrative	PROJECT NARRATIVE.doc
Certifications/Assurances/Representations	CERTIFICATIONS-ASSURANCES.doc
ADDITIONAL FILES	
Attachment 1 FFRDC Attachment (if applicable)	FFRDC ATTACHMENT.doc
Attachment 2 BIOGRAPHICAL SKETCH	BIO ATTACHMENT.doc
Attachment 3 COMMITMENT LETTERS	CLTP ATTACHMENT.pdf

4.6 APPLICATION FILE (DEC 2003)

Applicants must complete a SF 424 application form. **Save this form as a Word file, named "APPLICATION.doc."**

The SF 424 is titled "APPLICATION.doc" and is posted with this Announcement on the IIPS site.

4.7 BUDGET FILE (DEC 2003)

Applicants must complete a separate DOE F 4600.4 for each year of support requested and a cumulative budget for the total project period.

You may request funds under any of the categories listed as long as the item and amount are necessary to perform the proposed work and are not precluded by the cost principles or program funding restrictions (See Section IV). **Save these budget forms in a single Word file, named "BUDGET.doc."**

The DOE F 4600.4 is titled "BUDGET.doc" and is posted with this Announcement on the IIPS site.

BUDGET FILE FOR FFRDC PARTICIPANT, IF ANY

If a non-DOE FFRDC contractor is to perform a portion of the work, provide a separate budget for the FFRDC contractor's work effort.

If a DOE FFRDC contractor is to perform a portion of the work, provide a DOE Field Work Proposal in accordance with the requirements in DOE Order 412.1 Work Authorization System. DOE O 412.1 is available at:

http://www.directives.doe.gov/pdfs/doe/doetext/neword/412/o4121.pdf

All FFRDC budgets must be saved as a Word file named "FFRDC ATTACHMENT.doc".

4.8 BUDGET JUSTIFICATION FILE (MAR 2004)

Justify proposed direct labor, travel, consultants, large subawards, large or unique "other direct costs", equipment, etc. Provide an explanation of the source, nature, amount and availability of any proposed cost sharing. **Save this information in a Word file, named "BUDGET JUSTIFICATION.doc".**

The following budget detail is required. Failure to provide the detailed cost information as described in the

instructions will result in an incomplete application. If a minimum cost share is required by this funding opportunity announcement, the applicant shall stipulate in the application the source and amount of cost sharing and the value of third party in-kind contributions proposed to meet the requirement. Additionally teaming members and subcontractors are also required to submit the below information with their budgets.

PERSONNEL -- In support of the proposed personnel costs, provide a supplemental schedule that identifies the labor hours, labor rates, and cost by labor classification for each budget year. Also indicate the basis of the labor classification, number of hours, and labor rates. An example of the basis for the labor classification and number of hours could be past experience, engineering estimate, etc. An example of the basis for the labor rates could be actual rates for the individuals who will perform the work or an average labor rate for the labor classification or a departmental average rate.

FRINGE BENEFITS -- Provide the method used to calculate the proposed rate amount. If a fringe benefit rate has been negotiated with, or approved by, a Federal Government agency, provide a copy of the agreement. If no rate agreement exists, provide a detailed list of the fringe benefit expenses (e.g., payroll taxes, insurances, holiday and vacation pay, bonuses) and their associated costs. Identify the base for allocating these fringe benefit expenses.

TRAVEL -- For each proposed trip, provide the purpose, number of travelers, travel origin and destination, number of days, and a breakdown of costs for airfare, lodging, meals, car rental, and incidentals. The basis for the airfare, lodging, meals, car rental, and incidentals must be provided, such as past trips, current quotations, Federal Travel Regulations, etc.

EQUIPMENT -- Provide an itemized list of each piece of equipment, its unit costs, and the basis for estimating the cost, for example, vendor quotes, catalog prices, prior invoices, etc.

SUPPLIES -- Provide an itemized list of supplies; identify the quantity of each item, its unit cost, and the basis for estimating the cost, for example, vendor quotes, catalog prices, prior invoices, etc.

CONTRACTUAL

Consultants -- Provide the hourly or daily rate along with the basis for the rate. Furnish resumes or similar information regarding qualifications or experience. Provide at least two invoices reflecting hourly or daily rates charged to customers other than the Government. A statement signed by the consultant certifying his or her availability and salary must be provided. If travel or incidental expenses are to be charged, give the basis for these costs.

Subcontractors -- Identify each planned subcontractor and its total proposed budget. Each subcontractor's budget and supporting detail should be included as part of the Applicant's budget narrative. In addition, the Applicant shall provide the following information for each planned subcontract: a brief description of the work to be subcontracted; the number of quotes solicited and received; the cost or price analysis performed by the Applicant; names and addresses of the subcontractors tentatively selected and the basis for their selection; i.e. low bidder, delivery schedule, technical competence; type of contract and estimated cost and fee or profit; and, affiliation with the Applicant, if any.

CONSTRUCTION -- Provide detail of construction costs, if applicable.

OTHER DIRECT COSTS -- Provide an itemized list with costs for any other item proposed as a direct cost and state the basis for each proposed item.

INDIRECT COSTS -- If indirect rates have been negotiated with or approved by a Federal Government agency, please provide a copy of the latest rate agreement. If you do not have a current rate agreement, submit an indirect cost rate proposal which includes the major base and pool expense groupings by line item and dollar amount. In either case, provide a breakdown of the proposed indirect costs for each of your accounting periods included in the application. Identify the rate and allocation base for each indirect cost, such as Overhead, General and Administrative, Facilities Capital Cost of Money, etc.

COST SHARING -- Identify the percentage level and source of cost sharing for the proposed project. Firm funding commitments are expected and documentation of those commitments must be included in the application. Additionally, the impact of DOE's cost share to the viability of the project must be addressed, to include justification for the need for Federal Funds.

NOTE: The total project cost (i.e. sum of Applicant and other participants plus DOE cost shares) must be reflected in each budget form.

A detailed estimate of the cash value (basis of and the nature, e.g., equipment, labor, facilities, cash, etc.) of all contributions to the project by each participant must be provided. Note that "cost-sharing" is not limited to cash investment. In-kind contributions (e.g., contribution of services or property; donated equipment, buildings, or land; donated supplies; or unrecovered indirect costs) incurred as part of the project may be considered as all or part of the cost share. The "cost-sharing" definition is contained in 10 CFR 600.30, 600.101, 600.123, 600.224, 600.302, 600. 313 and OMB Circular A-110.

Fee or profit will not be paid to the recipients of financial assistance awards. Additionally, foregone fee or profit by the Applicant shall not be considered cost sharing under any resulting award. Reimbursement of actual costs will only include those costs that are allowable and allocable to the project as determined in accordance with the applicable cost principles prescribed in 10 CFR 600.127, 10 CFR 600.312 or 10 CFR 600.318.

4.9 PROJECT SUMMARY/ABSTRACT (DEC 2003)

The project summary/abstract must contain a summary of the proposed activity suitable for publication. It should be a self-contained document that identifies the name of the applicant, the principal investigator/project director, the project title, the objectives of the project, methods to be employed, the potential impact of the project (i.e., benefits, out comes), and participants (for collaborative projects). It should be informative to other persons working in the same or related fields and, insofar as possible, understandable to a scientifically or technically literate lay reader. This document must not include any proprietary or sensitive business information as the Department may make it available to the public. The project summary abstract must not exceed 1 page when printed using standard 8.5" by 11 paper with 1" margins (top, bottom, left and right). The form for the Project Summary is the DOE F 540.1-2. **Save this information in a Word file, named "PROJECT SUMMARY.doc"**

The DOE F 540.1-2 is titled “PROJECT SUMMARY.doc” and is posted with this Announcement on the IIPS site.

4.10 PROJECT NARRATIVE FILE (DEC 2003)

This file shall include a cover page indicating the funding opportunity notice number, name and address of the Applicant, point of contact, telephone/FAX number/E-Mail address, title of project, and date of application.

The project narrative file must be formatted to separately address each of the sections listed below. It is requested that the project narrative not exceed thirty (30) pages, single spaced, 1" margins (top, bottom, left, right), and when printed will fit on size 8 1/2" by 11" paper. The type must be legible and not smaller than 11 point. Evaluators will review only the number of pages specified. Any applications exceeding these limitations may result in a weakness to their overall score based on technical evaluation Criterion 3 – Applicant and Team Member Roles & Capabilities.

Save this information in a Word file named "PROJECT NARRATIVE.doc"

Unnecessarily elaborate applications are not desired. Elaborate art work, graphics and pictures will increase the document file size. If the project narrative file size is over 5MB, we request that you use a "Zip" file compression

software, such as WinZip software, to reduce the time needed to download the file.

This file should provide a clear description of the work to be undertaken and how you plan to accomplish it. It must be formatted to address each of the merit review criterion and sub-criterion listed in Section V. Provide sufficient information so that the reviewers will be able to evaluate the application in accordance with these merit review criteria.

DOE WILL EVALUATE AND CONSIDER ONLY THOSE APPLICATIONS THAT ADDRESS SEPARATELY EACH MERIT REVIEW CRITERION AND SUB-CRITERION. The applicant should organize the Technical Discussion as follows:

1) Technical Merit (35%)

- Provide a detailed discussion of the need or problem the technology or product will address and the major issues and key risks in the development of the proposed technology. Provide a detailed discussion to validate that the proposed technology or product is technically superior to currently available products.
- Provide a detailed discussion of the proposed approach to technology or product development given the current development status of the technology, and overall impact of successful project completion to future success in the marketplace. Provide a detailed discussion to prove the feasibility of the proposed technology or product, the scientific merit (based on sound scientific and engineering principles), and the degree to which the technology or product is innovative and unique.
- Provide a proposed work plan and schedule and include milestones and performance metrics in the work plan to gauge technical progress. Provide a PERT (Program Evaluation and Review Technique) chart or equivalent depicting the project schedule, milestones, and interrelationship of the project tasks. Identify the critical path which identifies the sequential tasks which, if not completed on time, will result in a delay in the overall project schedule. Define all significant milestones in a milestone log and depict them on the schedule.
- Provide a table listing the estimated labor hours and labor categories (e.g., project manager, principal investigator, engineering, technician, scientific, clerical) required for each task and provide totals for each maturation stage. Include a table showing labor hours and labor categories for any proposed subcontracting or consulting effort for each task. Discuss the rationale used to develop estimates for labor hours, labor categories, subcontracting effort, and consulting effort. Cost information is not to be included in the technical application volume. Explain the purpose of the subcontract or consulting effort.

2) Energy, Environmental, and Economic Benefits (25%)

Note: As determined by the applicant, the proposed product performance (efficacy) should be used in the estimation of energy benefits in Criterion #2. The capability of the applicant's proposed product to save energy is required.

- Provide evidence of significant energy benefits and technical performance expected from the proposed technology or product. Use the "Guide for Evaluation of Energy Savings Potential – Solid State Lighting Research and Development" contained in Exhibit C to determine the energy savings benefits.
- Provide evidence of significant environmental benefits from the proposed technology or product. Environmental benefits include, but are not limited to: reduced global warming potential, increased protection of the stratospheric ozone layer, lower direct releases of water, air and ground pollutants, improved indoor air quality, improved recyclability and beneficial human health impacts. Determine potential reductions in emissions of carbon dioxide from the proposed technology according to the guidelines contained in Exhibit C.
- Provide evidence of significant economic market potential for the proposed technology or product.

3) Applicant and Participant Roles and Capabilities (15%)

- Provide a detailed discussion of current corporate experience and success in similar projects resulting in successful technology development and commercialization or technology transfer to commercial

product(s).

- Provide a detailed discussion of experience and availability of key personnel to complete the proposed project. Relative to the nature and time scale of the proposed project, evaluate team capabilities for both technical expertise and, if needed for the success of the project, product commercialization and/or technology transfer expertise. For key personnel which are not staff members of the applicant's organization, provide evidence of the availability of such personnel, consistent with their role in the proposed tasks, to validate the overall team experience being proposed.
- Provide a detailed discussion of adequacy (quality, availability and appropriateness) of facilities and equipment to accommodate the proposed project. Identify any major equipment needed for the proposed project which will need to be acquired during the course of the project.

4) Industrial Involvement and Commercialization Potential (15%)

- Provide a discussion of the commercialization strategy for the proposed technology or product and of the intellectual property rights and/or institutional alliances to execute the commercialization strategy.
- Provide a detailed discussion of the viability and practicality of the proposed technology, product or information to meet the needs of the target market in a cost effective manner without major market restructuring considering potential technical, regulatory, economic, environmental, production or other issues impacting market success.
- Provide a detailed discussion of the corporate commitment to the proposed project by exceeding the minimum required cost share and/or providing in-kind contributions to enhance commercialization potential.

5) SSL Partnership Membership (10%)

- Provide documentation that either verifies that the prime performer is already a member of the SSL Partnership or commits to become a member before award of a selected application.

STATEMENT OF PROJECT OBJECTIVES (SOPO)

The Department of Energy's National Energy Technology Laboratory uses a specific format for Statement of Project Objectives in its awards. In Announcements such as this one, where the Government does not provide a Statement of Project Objectives, the Applicant is to provide one, which the DOE will then use to generate the Statement of Project Objectives to be included in the award. Several specific tasks have also been provided in the following format for the Applicant to insert into the Statement of Project Objectives at the appropriate location.

The project narrative must contain a single, detailed Statement of Project Objectives that addresses how the project objectives will be met. The Statement of Project Objectives must contain a clear, concise description of all activities to be completed during project performance and follow the structure discussed below. The Statement of Project Objectives may be released to the public by DOE in whole or in part at any time. It is therefore required that it shall not contain proprietary or confidential business information.

The Statement of Project Objectives is generally 3 to 4 pages in total for the proposed work. <u>The Statement of Project Objectives is considered to be part of the Project Narrative and is therefore included in the 30 page limit.</u> Applicants shall prepare the Statement of Project Objectives in the following format:

FORMAT FOR STATEMENT OF PROJECT OBJECTIVES

TITLE OF WORK TO BE PERFORMED

(Insert the title of work to be performed. Be concise and descriptive.)

A. OBJECTIVES

Include one paragraph on the overall objective(s) of the work. Also, include objective(s) for each phase/maturation stage of the work.

B. SCOPE OF WORK

This section should not exceed one-half page and should summarize the effort and approach to achieve the objective(s) of the work for each Phase.

C. TASKS TO BE PERFORMED

Tasks, concisely written, should be provided in a logical sequence and should be divided into the phases/maturation stages of the project. This section provides a brief summary of the planned approach to this project.

PHASE I

Task 1.0 - (Title)

(Description)

Subtask 1.1 (Optional)

(Description)

Task 2.0 - (Title)

PHASE II (Optional)

Task 3.0 - (Title)

D. DELIVERABLES

The periodic, topical, and final reports shall be submitted in accordance with the attached "Federal Assistance Reporting Checklist" and the instructions accompanying the checklist.

[Note: The Recipient shall provide a list of deliverables other than those identified on the "Federal Assistance Reporting Checklist" that will be delivered. These reports shall also be identified within the text of the Statement of Project Objectives. See the following examples:

1. Task 1.1 - (Report Description)
2. Task 2.2 - (Report Description)]

In addition to reports listed in the Federal Assistance Reporting Checklist in Exhibit A hereof, the Recipient shall submit the following to the DOE Project Officer. Note that the following is <u>not</u> to be submitted through the official NETL AAD document control system:

Monthly Highlight Communications: This update shall be submitted via e-mail no later than the 15th day of each month and shall cover the activities of the previous month. Recipients shall use this highlight opportunity to communicate developments, achievements, changes and problems. The information shall be submitted in accordance with the following format:

Award Number
Title
Communication Period – Identify month and year of the communication period.
Task Update – Provide an update on work performed for each task during the period. Identify tasks by both the descriptive name and number.
Quarterly Expanded Summary - Monthly Highlight Communications for December, March, June, and September shall include an expanded summary of project results and the current status

of all project tasks. This summary shall be in sufficient detail to place the information communicated in the Monthly Highlight Communications for the current month and preceding two months in the context of the full project.
Discussion Topics – Identify issues that require DOE Project Manager attention or action.
Key Milestones and Significant Accomplishments – In a short paragraph per milestone or accomplishment, identify achievement of key project milestones, noteworthy advancements in research, design, manufacture or commercialization activities of the project, patent-related developments, and important breakthroughs that resolve critical science and technology risks or development barriers.
Presentations & Publications – Identify and include briefing packages, press releases, articles, and papers planned, developed and/or given that discuss the project. [Note: Copies of these presentations and publications provided with the Monthly Highlight Communication shall not include proprietary information.]
Site Visits – Identify site visits planned and given with high level corporate or government officials.
Travel – Identify travel planned or completed to accomplish/manage project tasks.

E. BRIEFINGS/TECHNICAL PRESENTATIONS (If applicable)

The Recipient shall prepare detailed briefings for presentation to the DOE Project Officer at the NETL facility located in Pittsburgh, PA or Morgantown, WV or other location specified by the DOE Project Officer. Briefings shall be given by the Recipient to explain the plans, progress, and results of the technical effort.

The Recipient shall provide and present a technical paper(s) at the DOE/NETL Annual Contractor's Review Meeting to be held at the NETL facility located in Pittsburgh, PA; Morgantown, WV; or other location specified by the DOE Project Officer.

4.11 CERTIFICATIONS/ASSURANCES/REPRESENTATIONS FILE (DEC 2003)

Applicants must complete the DOE certifications/assurances/representations information. **Save this information in a single Word file named "CERTIFICATIONS-ASSURANCES.doc."**

The DOE Certifications, Assurances and Representations are located in one file titled "CERTIFICATIONS-ASSURANCES.doc" and are posted with this Announcement on the IIPS site.

This program is covered under Title XX through XXIII of the Energy Policy Act (EPACT) of 1992. If an applicant is a business entity other than an organization of they type described in 501(c)(3) of the Internal Revenue Code of 1954, the applicant must complete the form set with the EPACT Representation and provide the appropriate EPACT Representation, (i.e., EPACT Representation for Awards Under $100,000 or EPACT Representation for Awards of $100,000 or more).

4.12 ATTACHMENT 1 FFRDC ATTACHMENT (DEC 2003)

FFRDC Budgets and a DOE Field Work Proposal in accordance with the requirements in DOE Order 412.1 Work Authorization System, (http://www.directives.doe.gov/pdfs/doe/doetext/neword/412/o4121.pdf) must be provided, if applicable. **Save these as a Word file named "FFRDC ATTACHMENT.doc"**

4.13 ATTACHMENT 2 BIOGRAPHICAL SKETCH (DEC 2003)

Provide a biographical sketch for the project director/principal investigator, co-project directors/principal investigators, and other roles critical to project success. **Save this information in a single Word file, named "BIO ATTACHMENT.doc"**. The biographical information must not exceed 2 pages for each person when printed on 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right) with font not smaller than 11 point and must include:

Education. Undergraduate, graduate and postdoctoral training, provide institution, major/area, degree and year.

Positions: Beginning with the current position list, in chronological order, professional/academic positions with a brief description.

Publications. A list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the same sequence in which they appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically.

Patents, copyrights and software systems developed may be provided in addition to or substituted for publications.

Synergistic Activities. List no more than 5 professional and scholarly activities related to the effort proposed.

4.14 ATTACHMENT 3 COMMITMENT LETTERS FROM THIRD PARTIES CONTRIBUTING TO COST SHARING (OCT 2003)

If a third party, (i.e., a party other than the organization submitting the application) proposes to provide all or part of the required cost sharing, the applicant must include a letter from the third party stating that it is committed to providing a specific minimum dollar amount of cost sharing. The letter should also identify the proposed cost sharing (e.g., cash, services, and/or property) to be contributed. Letters must be signed by the person authorized to commit the expenditure of funds by the entity and be provided in a PDF format. **Save this information is a file named "CLTP ATTACHMENT.pdf".**

4.15 MORE THAN ONE APPLICATION (JAN 2003)

You may submit more than one application. Each application must have its own unique title on the subject line (i.e., project title and principal investigator/project director, if any). For each application, you must first click on "Create Application" and then complete the information requested.

4.16 APPLICATION DUE DATE (OCT 2003)

Applications and amendments of applications must be received by July 8, 2004, not later than 8:00 PM Eastern Time. You are encouraged to transmit your application well before the deadline.

APPLICATIONS, INCLUDING APPLICATION FILES, RECEIVED AFTER THE DEADLINE, AS DEMONSTRATED BY THE IIPS DATE/TIME STAMP WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.

4.17 INTERGOVERNMENTAL REVIEW - NONE (OCT 2003)

This program is not subject to Executive Order 12372, "Intergovernmental Review of Federal Programs".

4.18 FUNDING RESTRICTIONS (DEC 2003)

COST PRINCIPLES

Cost must be allowable in accordance with the applicable cost principles referenced in 10 CFR Part 600.

PRE-AWARD COSTS

Recipients may charge to an award resulting from this announcement pre-award costs that were incurred within the ninety (90) calendar day period immediately preceding the effective date of the award, if the costs are necessary for

the conduct of the project activities and are otherwise allowable in accordance with the applicable cost principles and the terms and conditions of the award. Recipients must obtain the prior approval of the contracting officer for any pre-award costs that are for periods greater than this 90 day calendar period.

Pre-award costs are incurred at the applicant's risk. DOE is under no obligation to reimburse such costs if for any reason the applicant does not receive an award or if the award is made for a lesser amount than the applicant expected.

FOREIGN TRAVEL

Cost of foreign travel is not allowable under an award made as a result of this announcement.

4.19 OTHER SUBMISSION REQUIREMENTS (OCT 2003)

ELECTRONIC SUBMISSION

Applications must be submitted through the DOE Industry Interactive Procurement System (IIPS) at http://e-center.doe.gov. Instructions on how to submit an application or an application amendment and how to register, submit questions, and view questions and answers are located on the web site at http://e-center.doe.gov, click on the "Help" button and click on "Frequently Asked Questions".

Prepare all the required files in accordance with the instructions in this announcement prior to starting the transmission process. Submit the entire application package in one IIPS session (i.e., do not logoff before all the files are submitted).

When you are ready to submit your application, go to http://e-center.doe.gov and complete the IIPS cover page. Enter the project title and the principal investigator/project director, if any, in the "Subject" block. Then attach each file in the corresponding block in accordance with the IIPS guidance. Follow the instructions for submitting the application.

If you have any problems accessing information or submitting your application, contact the Help Desk at 1 800-683-0751 and select option 1, or send an email to HelpDesk@pr.doe.gov. ONLY APPLICATIONS SUBMITTED THROUGH IIPS WILL BE CONSIDERED FOR AWARD.

ELECTRONIC SIGNATURE

Applications submitted through IIPS constitute submission of electronically signed applications. The name of the authorized organizational representative (i.e., the administrative official, who, on behalf of the proposing organization, is authorized to make certifications and assurances or to commit the applicant to the conduct of a project) must be typed in the signature block on the form to be accepted as an electronic signature. Do not submit a scanned copy of the signed document.

IIPS REGISTRATION

In order to submit an application, you must be authorized by the applicant (i.e., institution or business entity) to submit an application on its behalf and you must register in IIPS. You are encouraged to register as soon as possible. You only have to register once to apply for any DOE award. To register go to http://e-center.doe.gov and follow the registration instructions.

SECTION V - APPLICATION REVIEW INFORMATION

5.1 INITIAL REVIEW CRITERIA (OCT 2003)

Prior to a comprehensive merit evaluation, DOE will perform an initial review to determine that (1) the applicant is eligible for an award; (2) the information required by the announcement has been submitted; (3) all mandatory requirements are satisfied; and (4) the proposed project is responsive to the objectives of the funding opportunity announcement.

5.2 MERIT REVIEW CRITERIA (APR 2004)

Applications submitted in response to this funding opportunity will be evaluated and scored in accordance with the criteria and weights listed below:

1) Technical Merit (35%)

- Discussion of how the proposed technology or product will address the need or problem and the potential superiority of the proposed technology or product over currently available products.
- Validity of the proposed approach and likelihood of success based on current status and the scientific merit of the proposed approach.
- Development of a comprehensive and complete work plan and schedule with milestones and interrelated tasks that leads to the successful completion of the project.
- Legitimacy of the proposed labor hours and categories proposed for the work plan. The need for and description of any subcontracting effort.

2) Energy, Environmental, and Economic Benefits (25%)

- The legitimacy and impact of the energy benefits calculated using the "Guide for Evaluation of Energy Savings Potential – Solid State Lighting Research and Development" contained in Exhibit C.
- The legitimacy and impact of the environmental benefits which include, but are not limited to: reduced global warming potential, increased protection of the stratospheric ozone layer, lower direct releases of water, air and ground pollutants, improved indoor air quality, improved recyclability, beneficial human health impacts and potential reductions in emissions of carbon dioxide from the proposed technology according to the guidelines contained in Exhibit C.
- The legitimacy and impact of the economic benefits as it pertains to the market potential for the proposed technology

3) Applicant and Participant Roles and Capabilities (15%)

- Evidence of current corporate experience and success in similar projects which lead to successful technology development and commercialization or technology transfer to commercial product(s)
- Discussion of experience and availability of key personnel to complete the proposed project, including personnel involved in technical, commercialization and/or technology transfer.
- Discussion of adequacy (quality, availability and appropriateness) of facilities and equipment to accommodate the proposed project.

4) Industrial Involvement and Commercialization Potential (15%)

- Discussion of the commercialization strategy for the proposed technology or product and of the intellectual property rights and/or institutional alliances to execute the commercialization strategy.
- Discussion of the viability and practicality of the proposed technology, product or information to meet the needs of the target market in a cost effective manner without major market restructuring considering potential technical, regulatory, economic, environmental, production or other issues impacting market success.
- Discussion of the corporate commitment to the proposed project by exceeding the minimum required cost

share and/or providing in-kind contributions to enhance commercialization potential.

5) SSL Partnership Membership (10%)

- Documentation that either verifies that the prime performer is already a member of the SSL Partnership or commits to become a member before award of a selected application

5.3 OTHER SELECTION FACTORS (OCT 2003)

These factors, while not indicators of the Application's merit, e.g., technical excellence, cost, Applicant's ability, etc., may be essential to the process of selecting the application(s) that, individually or collectively, will best achieve the program objectives. Such factors are often beyond the control of the Applicant. Applicants should recognize that some very good applications may not receive an award because they do not fit within a mix of projects which maximizes the probability of achieving the DOE's overall research and development objectives. Therefore, the following Program Policy Factors may be used by the Selection Official to assist in determining which of the ranked application(s) shall receive DOE funding support.

1. It may be desirable to select for award a group of projects which represents a diversity of technical approaches and methods;

2. It may be desirable to support complementary and/or duplicative efforts or projects, which, when taken together, will best achieve the research goals and objectives;

3. It may be desirable to select different kinds and sizes of organizations in order to provide a balanced programmatic effort and a variety of different technical perspectives;

4. It may be desirable, because of the nature of the energy source, the type of projects envisioned, or limitations of past efforts, to select a group of projects with a broad or specific geographic distribution.

5. It may be desirable to select project(s) of less technical merit than other project(s) if such a selection will optimize use of available funds by allowing more projects to be supported and not be detrimental to the overall objectives of the program.

The above factors will be independently considered by the Selection Official in determining the optimum mix of applications that will be selected for support. These policy factors will provide the Selection Official with the capability of developing, from the competitive funding opportunity, a broad involvement of organizations and organizational ideas, which both enhance the overall technology research effort and upgrade the program content to meet the goals of the DOE.

5.4 REVIEW AND SELECTION PROCESS (OCT 2003)

MERIT REVIEW

Applications that pass the initial review will be subjected to a merit review in accordance with the Office of Energy Efficiency and Renewable Energy merit review procedures which were published in the Federal Register on December 20, 2001 (Vol. 66, No. 245).

SELECTION

The Selection Official will consider the merit review recommendation, program policy factors, and the amount of funds available.

DISCUSSIONS AND AWARD

The Government may enter into discussions with a selected applicant for any reason deemed necessary, including

but not limited to,: (1) the budget is not appropriate or reasonable for the requirement; (2) only a portion of the application is selected for award; (3) the Government needs additional information to determine that the recipient is capable of complying with the requirements in 10 CFR 600; and/or (4) special terms and conditions are required. Failure to resolve satisfactorily the issues identified by the Government will preclude award to the applicant.

5.5 ANTICIPATED ANNOUNCEMENT AND AWARD DATES (OCT 2003)

DOE anticipates notifying applicants selected for award by September 23, 2004 and making awards by December 23, 2004.

SECTION VI - AWARD ADMINISTRATION INFORMATION

6.1 AWARD NOTICES (OCT 2003)

NOTICE OF SELECTION

DOE will notify applicants selected for negotiations leading to award. This notice of selection is not an authorization to begin performance. (See Section IV, Article 4.18 with respect to the allowability of pre-award costs.)

Organizations whose applications have not been selected will be advised as promptly as possible. This notice will explain why the application was not selected.

NOTICE OF AWARD

A Notice of Financial Assistance Award issued by the contracting officer is the authorizing award document. It includes, either as an attachment or by reference: (1) a budget that indicates the amounts, by categories of expenses, on which the agency has based its support; (2) the application; (3) applicable program regulations, if any; (4) special terms and conditions; (5) DOE assistance regulations at 10 CFR part 600, or, for Federal Demonstration Partnership (FDP) institutions, the FDP terms and conditions; and (6) a reporting checklist, which identifies the reporting requirements.

6.2 ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS (OCT 2003)

The administrative requirements and national policy requirements (e.g., "generally applicable requirements") for DOE grants and cooperative agreements are contained in 10 CFR Part 600, except for grants made to Federal Demonstration Partnership (FDP) institutions. The FDP terms and conditions and DOE FDP agency specific terms and conditions are located on the National Science Foundation web site at www.nsf.gov. "Generally applicable requirements" are defined in 10 CFR 600.12.

6.3 LOBBYING RESTRICTION (INTERIOR ACT FY 2004) (MAR 2004)

The awardee agrees that none of the funds obligated on this award shall be made available for any activity or the publication or distribution of literature that in any way tends to promote public support or opposition to any legislative proposal on which Congressional action is not complete. This restriction is in addition to those prescribed elsewhere in statute and regulation.

A copy of the DOE "Lobbying Brochure" which provides a summary of the statutory and regulatory restrictions regarding lobbying activities for Federal contractors can be found at

http://professionals.pr.doe.gov/ma5/MA-5Web.nsf/Procurement/Lobbying+Brochure?OpenDocument

6.4 NOTICE REGARDING THE PURCHASE OF AMERICAN-MADE EQUIPMENT AND PRODUCTS -- SENSE OF CONGRESS (MAR 2004)

It is the sense of the Congress that, to the greatest extent practicable, all equipment and products purchased with funds made available under this award should be American-made.

6.5 COMPLIANCE WITH BUY AMERICAN ACT (MAR 2004)

In accepting this award, the Recipient agrees to comply with sections 2 through 4 of the Act of March 3, 1933 (41 U.S.C. 10a-10c, popularly known as the "Buy American Act"). The Recipient should review the provisions of the Act to ensure that expenditures made under this award are in accordance with it.

6.6 REPORTING (NOV 1998)

Failure to comply with the reporting requirements contained in this award will be considered a material noncompliance with the terms of the award. Noncompliance may result in a withholding of future payments, suspension or termination of the current award, and withholding of future awards. A willful failure to perform, a history of failure to perform, or of unsatisfactory performance of this and/or other financial assistance awards, may also result in a debarment action to preclude future awards by Federal agencies.

6.7 ENVIRONMENTAL, SAFETY & HEALTH (OCT 2003)

The recipient must comply with applicable Federal, State, and local environmental, safety and health laws and regulations for work performed under this award.

6.8 NOTICE REGARDING UNALLOWABLE COSTS AND LOBBYING ACTIVITIES (NOV 1998)

Recipients of financial assistance are cautioned to carefully review the allowable cost and other provisions applicable to expenditures under their particular award instruments. If financial assistance funds are spent for purposes or in amounts inconsistent with the allowable cost or any other provisions governing expenditures in an award instrument, the government may pursue a number of remedies against the Recipient, including in appropriate circumstances, recovery of such funds, termination of the award, suspension or debarment of the Recipient from future awards, and criminal prosecution for false statements.

Particular care should be taken by the Recipient to comply with the provisions prohibiting the expenditure of funds for lobbying and related activities. Financial assistance awards may be used to describe and promote the understanding of scientific and technical aspects of specific energy technologies, but not to encourage or support political activities such as the collection and dissemination of information related to potential, planned or pending legislation.

6.9 REPORTING REQUIREMENTS (DEC 2003)

The Reporting Requirements are identified on the Federal Assistance Reporting Checklist attached to the award agreement. See Exhibit A for the proposed Checklist for this program.

SECTION VII - AGENCY CONTACTS

7.1 QUESTIONS (OCT 2003)

Questions regarding the content of the announcement should be submitted through the "Submit Question" feature of the DOE Industry Interactive Procurement System (IIPS) at http:/e-center.doe.gov. Locate the announcement on IIPS and then click on the "Submit Question" button. Enter required information. You will receive an electronic notification that your question has been answered. DOE will try to respond to a question within 3 days, unless a similar question and answer have already been posted on the website.

Responses to questions may be viewed through the "View Questions" feature, button. If no questions have been answered, a statement to that effect will appear. You should periodically check "View Questions" for new questions and answers.

Questions regarding how to submit questions or view responses can be e-mailed to the IIPS HELP Desk at helpdesk@pr.doe.gov or by calling 1 (800) 683-0751.

SECTION VIII - OTHER INFORMATION

8.1 MODIFICATIONS (OCT 2003)

Notices of any modifications to this announcement will be posted on the DOE Industry Interactive Procurement System (IIPS).

If you register in IIPS, you may "Join the Mailing List" to receive an email when a modification or an announcement message is posted. To view modifications and announcement messages, locate the announcement on IIPS and click on the yellow folder next to the announcement number.

8.2 GOVERNMENT RIGHT TO REJECT OR NEGOTIATE (OCT 2003)

DOE reserves the right, without qualification, to reject any or all applications received in response to this announcement and to select any application, in whole or in part, as a basis for negotiation and/or award.

8.3 COMMITMENT OF PUBLIC FUNDS (OCT 2003)

The Contracting Officer is the only individual who can make awards or commit the Government to the expenditure of public funds. A commitment by other than the Contracting Officer, either explicit or implied, is invalid.

8.4 PROPRIETARY APPLICATION INFORMATION (OCT 2003)

An application may include data, including trade secrets and/or privileged or confidential commercial or financial information which the applicant does not want disclosed to the public or used for any purpose other than evaluation of the application (See 10 CFR 600.15). The use and disclosure of such data may be restricted, provided the applicant marks the cover sheet of the application with the following legend and specifies the pages of the application which are to be restricted:

> "The data contained in pages [ ] of this application have been submitted in confidence and contain trade secrets or proprietary information, and such data shall be used or disclosed only for evaluation purposes, provided that if this applicant receives an award as a result of or in connection with the submission of this application, DOE shall have the right to use or disclose the data herein to the extent provided in the award. This restriction does not limit the government's right to use or disclose data obtained without restriction from any source, including the applicant."

To protect such data, each line or paragraph on the pages containing such data must be specifically identified and marked with a legend similar to the following:

"Use or disclosure of the data set forth above is subject to the restriction on the cover page of this application."

8.5 EVALUATION BY NON-FEDERAL REVIEWERS (OCT 2003)

In conducting the merit review evaluation, the Government plans to use qualified non Federal personnel (e.g., DOE management and operating contractors, universities personnel, or other scientific/technical experts) as reviewers or advisors. The applicant, by submitting its application, consents to the use of non-Federal reviewers. Non-Federal reviewers will be required to sign a Conflict-of-Interest/Non-Disclosure Certificate prior to reviewing any application.

8.6 INTELLECTUAL PROPERTY DEVELOPED UNDER THIS PROGRAM (OCT 2003)

PATENT RIGHTS

The government will have certain statutory rights in an invention that is conceived or first actually reduced to

practice under a DOE award. 42 U.S.C. 5908 provides that title to such inventions vests in the United States, except where 35 U.S.C. 202 provides otherwise for nonprofit organizations or small business firms. However, the Secretary of Energy may waive all or any part of the rights of the United States subject to certain conditions. (See the clause entitled "Notice of Right to Request Patent Waiver" below.)

RIGHTS IN TECHNICAL DATA

Normally, the government has unlimited rights in technical data created under a DOE agreement. Delivery or third party licensing of proprietary software or data developed solely at private expense will not normally be required except as specifically negotiated in a particular agreement to satisfy DOE's own needs or to insure the commercialization of technology developed under a DOE agreement.

SPECIAL PROTECTED DATA STATUTES

This program is covered by a special protected data statute. The provisions of the statute provide for the protection from public disclosure, for a period of up to 5 years from the development of the information, data that would be trade secret, or commercial or financial information that is privileged or confidential, if the information had been obtained from a non-Federal party. Generally, the provision entitled, Rights in Data Programs Covered under Special Protected Data Statutes, (10 CFR 600 Appendix A to Subpart D), would apply to an award made under this announcement. This provision will identify data or categories of data first produced in the performance of the award that will be made available to the public, notwithstanding the statutory authority to withhold data from public dissemination, and will also identify data that will be recognized by the parties as protected data.

INTELLECTUAL PROPERTY PROVISIONS

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at http://www.gc.doe.gov/gcmain.html.

8.7 NOTICE OF RIGHT TO REQUEST PATENT WAIVER (OCT 2003)

Applicants may request a waiver of all or any part of the rights of the United States in inventions conceived or first actually reduced to practice in performance of an agreement as a result of this announcement, in advance of or within 30 days after the effective date of the award. Even if such advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver of the rights of the United States in identified inventions, i.e., individual inventions conceived or first actually reduced to practice in performance of the award. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.

Domestic small businesses and domestic nonprofit organizations will receive the patent rights clause at 37 CFR 401.14, i.e., the implementation of the Bayh-Dole Act. This clause permits domestic small business and domestic nonprofit organizations to retain title to subject inventions. Therefore, small businesses and nonprofit organizations do not need to request a waiver.

8.8 NOTICE REGARDING ELIGIBLE/INELIGIBLE ACTIVITIES (AUG 1999)

Eligible activities under this program include those which describe and promote the understanding of scientific and technical aspects of specific energy technologies, but not those which encourage or support political activities such as the collection and dissemination of information related to potential, planned or pending legislation.

DOE F 4600.2
(10-02)
All Other Editions Are Obsolete

EXHIBIT A
U.S. Department of Energy
FEDERAL ASSISTANCE REPORTING CHECKLIST

For additional instructions see FAL Management of Report Deliverables

1. **Identification Number:** DE-FXXX-XXNTXXXXX	2. **Program/Project Title:**

3. Recipient:

4. Reporting Requirements:	Frequency	No. of Copies	Addresses
MANAGEMENT REPORTING			
☐ Progress Report	Q**		
☐ Special Status Report (see Special Instructions)	A**		
SCIENTIFIC/TECHNICAL REPORTING			
(Reports/Products must be submitted with appropriate DOE F 241. Forms are available at https://www.osti.gov/elink/index.html)			
Report/Product — Form			
☒ Final Scientific/Technical Report — DOE F 241.3	F***	**Upload only 1 copy to the address in the next column at the interval specified in the previous column**	**All reports must be submitted via https://gowba.go.doe.gov/uploadreports**
☒ Conference papers/proceedings* — DOE F 241.3	A		
☐ Software/Manual — DOE F 241.4	A		
☐ Other (see special instructions) — DOE F 241.3			
** Scientific and technical conferences only*			
FINANCIAL REPORTING			
☒ SF-269, Financial Status Report (*Long Form*)	Q, F		
☐ SF-269A, Financial Status Report (*Short Form*)			
☒ SF-272, Federal Cash Transactions Report	Q, F		
CLOSEOUT REPORTING			
☒ Final Invention and Patent Report	F		
☒ Property Certification	F		
☐ Other (Final Narrative Report)			
OTHER REPORTING			
☐ Other (see special instructions)			

FREQUENCY CODES AND DUE DATES:

A - Within 5 calendar days after events or as specified.
F - Final; 90 calendar days after expiration or termination of the award.
Y - Yearly; 90 days after the end of the reporting period.
S - Semiannually; within 30 days after end of the reporting period.
Q - Quarterly; within 30 days after end of calendar quarter or portion thereof.

5. Special Instructions: Forms are available at: http://www.go.doe.gov/funding_post_award.html

Special Status Report: Provide notice of problems, delays, or adverse conditions, which materially impair the Recipient's ability to meet the objectives of the award or developments that have a significant favorable impact on the project. The report must include the remedial action to be taken to correct or resolve any problem or adverse condition.

** **Reports are to be written for public disclosure**. Reports should not contain any proprietary or classified information, other information not subject to release, or any information subject to export control classification.

*** **Final Scientific/Technical Report –** In addition to electronic submission, provide 2 hard copies to the DOE Project Officer specified in Block 11 of the Notice of Financial Assistance Award.

ATTACHMENT TO FEDERAL ASSISTANCE REPORTING CHECKLIST

INSTRUCTIONS FOR SUBMISSION OF TECHNICAL REPORTS

All reports required by this award shall be completed in accordance with the requirements of DOE Order 1332.2, "Uniform Reporting System for Federal Assistance".

1) Technical Report Due Dates

- Q (Quarterly): Due April 30, July 31, October 31, and January 31 (one month after the end of the reporting period). If an award occurs during the first 45 days of a Calendar Year (CY) quarter, the first quarterly report is due after that quarter, and if it occurs during the latter 45 days of the CY quarter, the first quarterly is due after the following CY quarter.

- S (Semi-Annual): Due April 30 and October 31 (one month after the end of the reporting period).

- F (Final): Due 90 days after the end of the effort.

2) Technical Report Content

- Technical Progress Report: Summarizes the work performed during a specific reporting period. It will include the technical and scientific results achieved.

- Topical Report: This report provides a comprehensive statement of the technical results of the work performed for a specific task or phase of the award, or reports details of significant new scientific or technological advances.

3) Final Technical Report

This report provides a technical accounting of the total work performed, and is a comprehensive description of the results achieved. The report format should contain an executive summary of the contents followed by a project summary. The main body should include, where applicable, facts, figures, analyses, and assumptions used during the life of the project to support the conclusions and recommendations. Appendices containing detailed computations and other reference materials may be included.

4) Final Report Submission

- Include a completed form DOE F 241.3, "Announcement of Department of Energy (DOE) Scientific and Technical Information (STI)" as the face page of the FINAL REPORT. If there is any patentable material or protected data in the report, this must be clearly indicated on the title page of the report and mark the appropriate block in Section K of the DOE F 241.3. Other than patentable material or protected data, reports should not contain any proprietary or classified information, other information not subject to release, or any information subject to export control classification.

- The preferred format is one file that includes all of the text, figures, illustrations, and photographs (photographs should be scanned and incorporated into the text). If the file contains graphics or photographs, the preferred application is Adobe Acrobat.

Acceptable word processing file formats include:

- Microsoft Word (v.6.0 or newer for PC)
- Adobe Acrobat for PC

If it is not possible to include all of the graphics (figures, illustrations, and photographs) in the same file as the text, GO shall accept the text in one of the above formats and the graphics as separate electronic image files. The preferred resolution for graphics is 150 to 300 dpi. The acceptable graphics file formats are: .tif, .gif, .jpg, .wpg, .bmp. Also include all fonts that were used in creating the document.

Only Attachments in the following electronic formats can be accepted:

- Microsoft PowerPoint (.ppt)
- Microsoft Excel (.xls)
- Adobe Acrobat (.pdf)

Only WinZip compressed files can be accepted.

5) Final Report Format

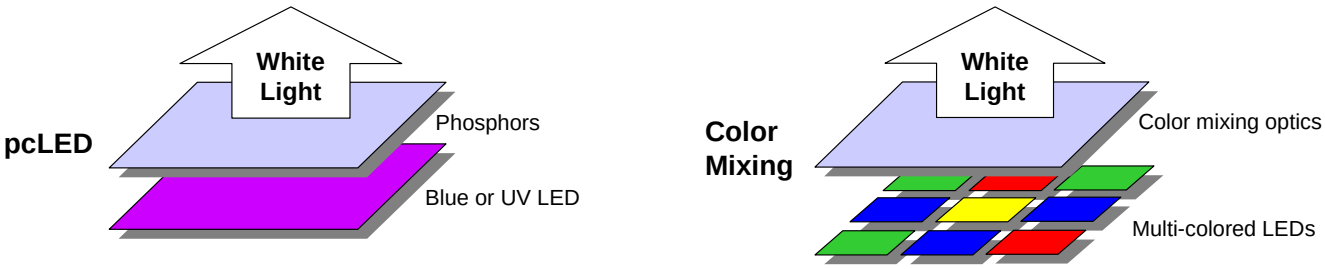
The Final Report should contain the following information:

- Face Page, DOE F 241.3
- Title Page
- Project Title
- DOE award number
- Document title (type of report)
- Period covered by report
- Name and address of recipient organization
- Contact information for technical point of contact including name, title, phone number, facsimile number, and electronic mail address

EXHIBIT B - LED TECHNOLOGY PERFORMANCE FORECASTS

In an effort to provide a better basis for assessing the energy savings potential of Solid State Lighting (SSL), the Department of Energy (DOE) studied the price and performance of white light emitting diode (LED) devices operating at a correlated color temperature (CCT) of approximately 3000K and a color rendering index (CRI) of 80 or higher. Two projection estimates were prepared, one for commercially available LEDs, and one for certain laboratory prototype LEDs. This appendix provides some of the background and rationale behind these projections.

LEDs are discrete semiconductor devices with a narrow-band emission that can be manufactured to emit in the ultraviolet (UV), visible or infrared regions of the spectrum. Alone, these LED chips or "die" are not well suited for general illumination applications as they do not produce the white-light required in these applications. To generate white-light for general illumination applications, the narrow spectral band of an LED's emission must be converted into white-light, or two (or more) discrete emissions must be mixed. White-light LED systems are typically based on one of two common approaches: (1) phosphor-conversion LEDs (pc-LEDs) and (2) discrete color-mixing. Figure A.1 shows these two approaches to white-light production.



(a) Phosphor-Conversion LED (b) Color-Mixing

Figure A.1. General Types of White-Light LED Devices

From a research perspective, pc-LEDs are often subdivided into two groups – one based on blue LEDs and one on UV LEDs. The blue LED approach creates white-light by blending a portion of the blue light emitted directly from the chip with light emission down-converted by a phosphor. The UV LED approach starts with a UV-emitting LED chip, that energizes phosphors designed to emit light in the visible spectrum. All the UV energy is adsorbed and converted into the visible spectrum by the phosphors. The color-mixing approach starts with discrete colored sources and uses color mixing optics to blend together the light output from these sources and create white-light emission.

Table A.1 provides performance information on these two approaches for producing white-light from LEDs. This table provides estimates of the maximum achievable efficacy for each light production mechanism.

Table A.1. Methods of LED White-light Production

Method	Mechanism	Maximum Efficacy*	Notes
pc-LED	Blue LED and phosphor	150 LPW @ 3000K, 80+ CRI	Blue LEDs devices provide a lower Stoke's shift than UV LED devices
pc-LED	UV LED and phosphor	125 LPW @ 3000K, 80+ CRI	Similar to blue LED & phosphor approach. Instead of visible blue, the visible light emission consists exclusively of phosphor emissions from UV excitation. Stoke's loss limits the maximum efficacy through this method.

Color-mixing	Two or more LED chips	200 LPW @ 3000K, 80+ CRI	Requires multi-chip mounting, and sophisticated optics for blending discrete colors.

For the phosphor converting blue LED approach, an LED chip emits blue light, generally around 460nm. Some of this light is emitted directly and some of it is down-converted by a phosphor from the 460nm wavelength (blue) to longer wavelengths (e.g., green, yellow, red) with wide-band emissions that blend with the blue to produce white-light. Nichia was the first manufacturer to use this method to produce white-light LED devices on a commercial scale. It has since been adopted by numerous other manufacturers as the method for white-light LEDs used in display and conspicuity applications. Recently, some manufacturers successfully lowered CCT and increased CRI by adding a second phosphor to the device, but at a cost to device efficacy. Such devices are currently available in high power packages with an efficacy of 20 LPW and a CRI of 90.

A pc-LED using a UV LED chip is similar to the blue LED system, but has some important differences. In this type of pc-LED, the LED radiates energy in the UV (340-380nm) or near-UV (<430nm) that excites phosphors, which down-convert the UV radiation into the visible wavelengths.[1] The discrete emissions from the phosphors combine to produce white light. However, like the hybrid approach, non-recoverable losses that occur during wavelength conversion (also known as Stoke's loss) currently limit the maximum efficacy achievable through this method. Manufacturers intend to make these products commercially available in 2004 and 2005. Initial product offerings are anticipated to be available in a wide range of color temperatures (2800K to 6000K) with an efficacy of 20 LPW and a CRI of 80 or higher.

One of the problems confronting manufacturers of pc-LED devices is their ability to maintain consistent quality white-light across a production line due to natural variations in LED (blue or UV) wavelength. The white-light produced by pc-LEDs is susceptible to variations in LED optical power, peak emission wavelength, temperature and optical characteristics. Thus, variations in color appearance can occur from one pc-LED to another. And, as LED devices migrate toward general illumination applications, this variation could become more problematic than it is for simple conspicuity applications like indicator lamps.

Breakthroughs in phosphor technology aside, discrete color-mixing is thought by many to promise the highest efficacy device. In this approach, manufacturers carefully mix discrete emissions from two or more LED chips to generate white light. This approach is accompanied by its own manufacturing challenges for blending the discrete colors. Analysis has shown, however, that with the color-mixing approach, high-quality, highly efficacious white-light can be produced. For example, three discrete color elements can produce white-light at a CCT of 3000K with 80 CRI at a cumulative efficacy in excess of 200 LPW, assuming 50% system efficiency. The principal advantage of the color-mixing method is that it does not involve phosphors, thereby minimizing phosphor conversion losses in the production of white-light. The principal drawback is increased complexity. It would require multi-chip mounting and may need sophisticated optics for blending the discrete colors. It may also require color control feedback circuitry that could deal with different degradation and thermal characteristics of the discrete die.

To project the anticipated efficacy improvement (lumens per watt) for laboratory white-light LED devices over time, S-curves were created with performance attributes based on data and projections available today. These projections are based on an accelerated investment scenario in SSL R&D, totaling $1 billion over ten years.[2] Figure A.2 presents these projections graphically.

[1] High-energy UV radiation can harm the human visual system.

[2] Accelerated investment scenario, matching 50/50 for industry and government contributions. This scenario is described in *Energy Savings Potential of Solid State Lighting in General Illumination Applications*, Building Technologies Program, Office of Energy Efficiency and Renewable Energy, US DOE, prepared by Navigant Consulting, Washington DC, November 2003. Available on-line at: www.netl.doe.gov/ssl

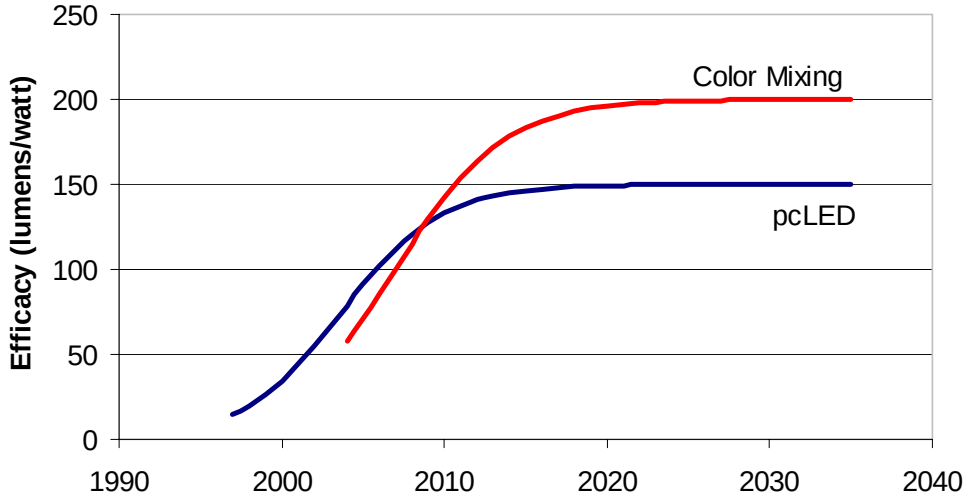


Figure A.2. Efficacy Plot for Laboratory White-Light LED Systems

Table A.2 presents the point values for the curves shown in Figure A.2. These values represent the projected laboratory device efficiencies anticipated under the pc-LED and color-mixing approaches for white-light production. Even though color mixing is anticipated to achieve the highest efficacy, manufacturers believe there will still be market demand for pc-LED devices.

Table A.2 Efficacies for Laboratory White-Light LED Systems

Efficacy (lumens/watt)	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Phosphor-converting (pc-LED)	66	79	91	102	112	121	128	133	146	149	150	150
Color Mixing LED	-	58	71	85	100	115	129	154	183	196	199	200
Cumulative Projection	66	79	91	102	112	121	129	154	183	196	199	200

The cumulative projection is the Department's estimate of future performance improvements in white-light LED device efficacy. If technical barriers can be overcome through carefully targeted and focused R&D initiatives, the Department believes that 200 lumens per watt performance is achievable in the long-term.

GUIDE FOR EVALUATION OF ENERGY SAVINGS POTENTIAL

SOLID STATE LIGHTING RESEARCH AND DEVELOPMENT

Office of Energy Efficiency and Renewable Energy

Building Technologies Program

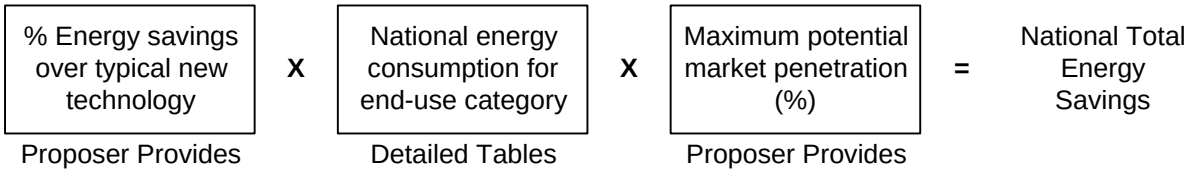
April 2, 2004

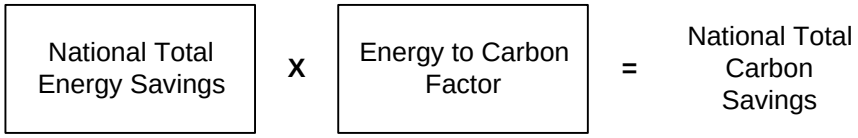
Introduction

This guide provides a method for estimating the savings in primary energy consumption and carbon emissions that could result from projects in solid state lighting research and development (SSLR&D). The objective of creating this standardized estimation method is to facilitate comparison of a wide variety of SSLR&D applications on an equitable basis. This guide provides a simple calculation framework and some of the constants and baseline energy estimates to use for that calculation.

The method is applicable to lighting technologies for both residential and commercial buildings. The method can accommodate lighting technologies that are at the very early stages of development as well as well-characterized technologies in the midst of a development cycle. It may not provide an accurate forecast of the likely impact of any one specific technology, however, by creating a consistent framework for analysis, the method will enable comparability amongst applications.

The savings estimates are expressed in terms of an annual national energy savings rate, based on the maximum likely market penetration of the proposed technology. A straightforward calculation method accommodating most technologies and markets is illustrated below:





The method requires four basic data items to generate an estimate of both primary energy savings and carbon emission savings. Those items and their sources are:

Item #	Description	Source
1	Primary energy consumption of the end use(s) targeted	Attached tables A and B
2	Performance level of typical new lighting technology	Attached tables A and B
3	Performance level of proposed technology	Proposer provides and substantiates
4	Expected market penetration of proposed technology	Proposer provides and substantiates

Items 1 and 2 are provided by the Department in Tables A and B, covering residential and commercial installations, respectively. Table C provides data to convert energy savings into carbon emissions savings, along with selected conversion constants, to ensure consistency among the estimates. Items 3 and 4 are provided by the proposer and must have adequate supporting justification for the performance and expected market penetration.

The performance level (item 3) must be based on the attributes of the proposed technology and must be substantiated by appropriately detailed engineering or scientific analysis, simulation modeling, and/or literature references. Substantiating data are necessary to justify the performance level used. In some cases, the lighting technology proposed will be a sub-component of one of the elements listed in Tables A and B. Sub-component technologies will require some additional calculations to adjust baseline energy before applying the methodology. Example #2 deals with this situation. The methodology should be based on comparing the performance level of the

proposed technology with the performance of the typical new technology currently used. In a replacement situation, it is implicitly assumed that replacement would occur regardless of the new technology. Therefore, the comparison is not based on the performance of the technology actually being replaced, but on the technology most likely to be used today.

The expected market penetration (item 4) is an estimate of the long-term penetration of the target market, on a percentage basis. The expected market penetration must be supported by a brief market analysis and/or supporting literature references. The brief market analysis must consider sector-specific economic factors (including expected first cost and payback period, relative to other technologies) and non-economic factors, which may limit the penetration of all of the target markets. (Non-economic factors include product physical size, building characteristics and institutional barriers.) A discussion of these factors may be necessary to justify the market penetration level used. It is possible to save energy with a technology that does not exceed the maximum efficiency available in the market, if the proposed technology has a lower first cost. The low-cost technology could create an incremental or additional market penetration above the present sales level for highly efficient products. This incremental market penetration would be used in calculating savings.

The savings calculation method outlined herein, if applied directly, may not accurately estimate the savings for certain technologies (such as crosscutting, integrated technologies) or niche applications. For these special cases, the proposer may modify this methodology or create a comparable methodology, as long as the methodology provides an equivalent level of calculation transparency, contains adequate justification through supporting data, and is fully consistent with the data in Tables A through C. The savings should be presented in terms of an annual national rate at maximum market penetration, not cumulative savings over several years nor a savings rate at some future point in time.

Lighting Technologies

The approach for estimating the relative energy savings of lighting technologies is based on the on-going replacement of lighting equipment in the existing building stock. The current energy consumption characteristics of existing buildings (Tables A and B) are used as the baseline for market penetration and savings estimates. This method implicitly uses the following approximations:

- all lighting equipment in all current buildings will eventually be replaced with new equipment, either due to equipment failure, functional, or economic factors.

- over the next 20 years, replacement of lighting equipment in existing buildings will produce a much larger market for energy savings than installations in newly-constructed buildings.

Therefore, there is no need to attempt to forecast the energy consumption characteristics of building lighting equipment in the future. Nor is there a need to calculate energy savings potential in new construction. Sufficient differentiation with respect to energy savings potential can be determined using the energy use characteristics of existing buildings.

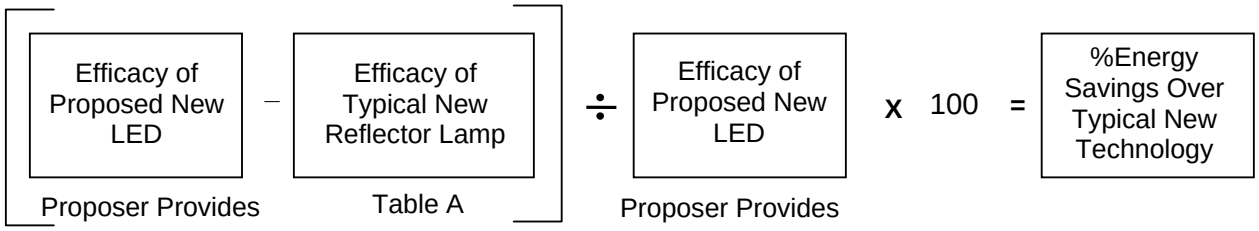
Example #1: This example deals with the development of a white-light LED designed to replace incandescent reflector lamps. The target market is both residential and commercial buildings. For the expected market penetration, the proposer estimates that 60% of the installed base of reflector lamps have the potential of being replaced by this new technology. This penetration level reflects the influence of several factors, including: the cost of electricity, the higher cost associated with this new technology, the sector-specific paybacks associated with this cost, and the number of applications into which it may be installed.

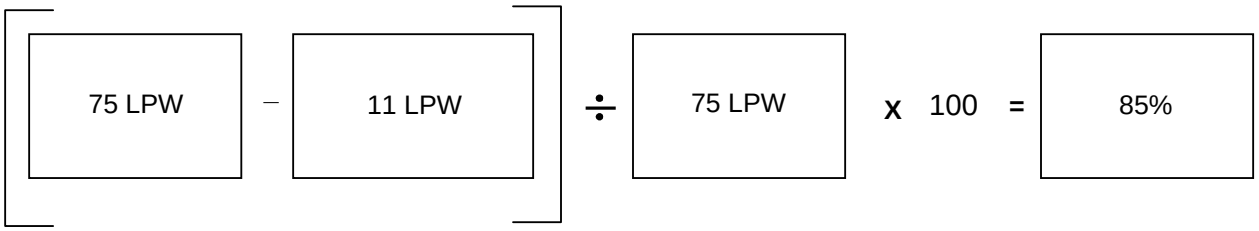
Example #2: This example considers the development of a white-light OLED device that is capable of replacing fluorescent lighting systems in commercial buildings. This is a system-to-system comparison, where a fluorescent system is replaced with an OLED fixture. The expected market penetration is 50% of the installed base, reflective of factors such as the operating and maintenance cost savings, and the sector-specific payback periods associated with the retail price of this product.

Example 1. White-Light LED Replacement for Incandescent

A newly developed, high-brightness, energy efficient, white-light LED is proposed to replace incandescent reflector lamps. From detailed engineering models based on laboratory results, the performance of these LEDs has been determined to be 75 lumens per watt. From market analyses, the maximum expected market penetration is 60% of the installed reflector lamp stock, limited primarily by the higher cost associated with this new technology, the sector-specific paybacks resulting from the energy savings, and the number of applications into which it may be installed. The efficacy and market penetration estimates were prepared by the proposer and have supporting documentation and data.

Step 1: Enter the efficacy of the proposed new white-light LED into two of the boxes. Look up the typical efficiency of a typical new reflector lamp in Table A[1] – 11 lumens per watt; this value is entered into the second box. Simple arithmetic provides the percent energy savings over a typical new reflector lamp as 85%.

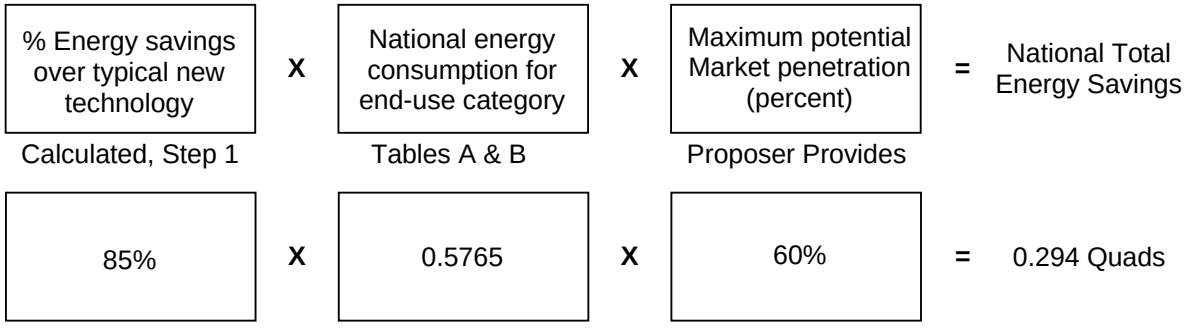




Step 2: This technology is applicable to reflector lamp applications in both the residential and commercial sectors. Look up the energy consumption of reflector lamps in tables A and B: the residential sector consumes 0.2540 quads and the commercial sector consumes 0.3225 quads. In total then, the installed base of incandescent reflector lamps is estimated to consume approximately 0.5765 quads each year.

Step 3: Provide the value of the potential market penetration, estimated by the proposer. The estimate provided is 60%.

Step 4: Place the three values (85%, 0.5765 quads, and 60%) into the energy savings estimate equation boxes and multiply. The result is a national total annual energy savings of 0.294 quads due to this new, more energy efficient lighting technology.



[1] Tables A through C are located at the end of Section V.

Step 5: To obtain the related carbon savings for the 0.294 quads, look up in Table C, the fuel-specific carbon emissions factor. The conversion value is 16.33 MMTC/quad (million metric tonnes carbon per quadrillion Btu). Insert the two values into the boxes, and multiply the energy savings by the conversion factor. The result is 4.80 million metric tonnes of carbon (MMTC) saved annually due to this new, energy efficient lighting technology.

National Total Energy Savings	X	Energy to Carbon Factor	=	National Total Carbon Emission Savings
0.294 quads	X	16.33 MMTC/quad	=	4.80 MMTC

Example 2. OLED Replacement for Fluorescent Lighting Fixture

This example considers the development of a white-light OLED device that is capable of replacing fluorescent lighting systems in commercial buildings. This is an example of a system-to-system comparison, whereby a fluorescent fixture is replaced by a new fixture incorporating an OLED device. A fluorescent system efficacy is estimated in Table B to be approximately 54 lumens per watt, adjusting the fluorescent lamp efficacy for an assumed 80% fixture efficiency and an 85% ballast efficiency. The expected market penetration of this device is 20% of the installed base, reflective of factors such as the first cost, operating and maintenance cost savings, and the sector-specific payback periods. Proposer must provide supporting documentation and/or data on the estimate of penetration.

Step 1: From modeling and/or measurements of a white-light OLED device, the proposer establishes that the product has a system efficacy of 60 lumens per watt. Convert that performance into a % energy savings over typical new fluorescent systems. Compared to a typical new fluorescent system of 54 lumens per watt, the proposed OLED is 10% more efficient.

Step 2: Look up the energy consumption attributable to fluorescent lighting in Table B. The value is 2.23 quads, which accounts for all linear fluorescent lighting systems in commercial buildings.

Efficacy of Proposed New OLED	–	Typical New Fluorescent System Efficacy	÷	Efficacy of Proposed New OLED	X	100	=	%Energy Savings Over Typical New Technology
Proposer Provides		Table B		Proposer Provides				
60 LPW	–	54 LPW	÷	60 LPW	X	100	=	10%

Step 3: The proposer estimates the level of anticipated market penetration for the OLED system, estimated and substantiated by the proposer. The estimate provided is 20%.

Step 4: Place the above three values (10%, 2.23 quads, and 20%) into the provided boxes and multiply. The result is a national total energy savings of 0.045 quads.

% Energy savings over typical new technology	X	National energy consumption for end-use category	X	Maximum potential Market penetration (percent)	=	National Total Energy Savings
Calculated, Step 1		Tables A & B		Proposer Provides		
10%	X	2.23	X	20%	=	0.045 Quads

Step 5: To obtain the related carbon emission savings for the 0.045 quads, look up the appropriate generic carbon emissions factor in Table C. The conversion value is 16.33 MMTC/quad (million metric tonnes of carbon per quad of primary energy). Insert the two values into the boxes, and multiply the energy savings by the conversion factor. The result is a 0.73 million metric tonne reduction of carbon emissions.

National Total Energy Savings	X	Energy to Carbon Factor	=	National Total Carbon Savings
0.045 quads	X	16.33 MMTC/quad	=	0.73 MMTC

INPUT TABLES

Table A: Residential End-Use Primary Energy Consumption and Typical Efficiencies

Type of Lighting	Total Energy Use (quads)[2]	Typical New Source Efficacy (lumens per watt)[3]	Typical New System Efficacy (lumens per watt)[4]
Incandescent General Service	1.7054	15	12
Incandescent Reflector	0.2540	11	9
Halogen Lamps	0.0609	20	16
Fluorescent Lamps (excluding CFL)	0.2026	65	44
Compact Fluorescent Lamp	0.0115	55	37
Mercury Vapor	0.0061	40	22
High Pressure Sodium	0.0010	80	45

Table B: Commercial End-Use Primary Energy Consumption and Typical Efficiencies

Type of Lighting	Total Energy Use (quads)[2]	Typical New Source Efficacy (lumens per watt)[3]	Typical New System Efficacy (lumens per watt)[4]
Incandescent General Service	0.7497	15	12
Incandescent Reflector	0.3225	11	9
Halogen Lamps	0.1504	20	16
Halogen Reflector, Low Voltage	0.0779	13	9
Misc. Incandescent Low Wattage	0.0405	10	8
Fluorescent Linear Tube	2.2297	80	54
Compact Fluorescent Lamp	0.1054	60	41
Circline and Misc. Fluorescent	0.0347	60	41
Mercury Vapor	0.0703	50	28
Metal Halide	0.3648	70	39
High Pressure Sodium	0.0608	100	56
Low Pressure Sodium	0.0014	140	78

[2] Quads of energy, accounting for the primary energy consumed at the generating power plant, incorporating all the generation, transmission and distribution losses associated with the delivery of electricity to the light fixture on site.
[3] Efficacy (lumen per watt) values will vary by wattage within a given lamp type. Constant values are proposed for the energy savings calculation for comparability of proposals.
[4] System efficacy represents the performance of the lamp, fixture and ballast/transformer (if necessary). Low voltage halogen transformers are assumed to be 90% efficient, fluorescent ballasts are assumed to be 85%, and HID ballasts are assumed to be 70%. For comparability of proposals, fixture efficiency for all sources is assumed to be 80%, however the Department recognizes that fixture efficiencies vary with fixture size, shape, treatment, and application. For example, compact fluorescent lamps have typical luminaire efficiencies in the range of 30% to 70%, while luminaires using incandescent reflector lamps have efficiencies from 65% to more than 90%.

Table C: Electricity Prices and Conversion Factors

Item	Value	Units
Residential Electricity Price (2002)	0.084	$/kWh
Commercial Electricity Price (2002)	0.079	$/kWh
Fuel Specific Carbon Emission Factors		
Electricity (2001)	16.33	Million metric tonnes carbon per quad
Average delivered Utility Power (2001)	11,030	BTU/kWh

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